D-Series Pumps

Installation and Operation Guide

TELEDYNE ISCO
Everywhereyoulook™

Part #69-1243-969 of Assembly #60-1243-998
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Rev. C, October 2015

Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Teledyne Isco recommends that you read this manual completely before placing the equipment in service.

Although Teledyne Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If a problem persists, call or e-mail Teledyne Isco technical support for assistance. Simple difficulties can often be diagnosed over the phone. For faster service, please have your serial number ready.

If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by technical support, including the use of the **Return Merchandise Authorization (RMA)** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Teledyne Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Customer Service

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Fax:	(402) 465-3022	
Email:	IscoCSR@teledyne.com	

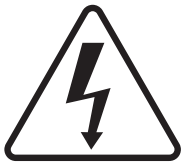
Technical Support

Phone:	Toll Free (866) 298-6174	(Samplers, Flow Meters and Multi-parameter Probes)
	Toll Free (800) 775-2965	(Syringe Pumps and Liquid Chromatography)
Email:	IscoService@teledyne.com or Iscoeps@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

Mail to:	P.O. Box 82531, Lincoln, NE 68501-2531
Email:	IscoInfo@teledyne.com

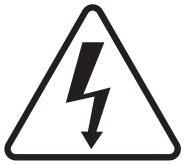
Warnings and Cautions



The lightning flash and arrowhead within the triangle is a warning sign alerting you to “dangerous voltage” inside the product.

The exclamation point within the triangle is a warning sign alerting you to important instructions in this manual.

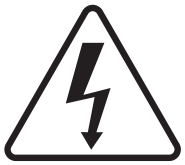
Symboles de Sécurité



Ce symbole signale la présence d’un danger d’électrocution.

Ce symbole signale l’existence d’instructions importantes relatives au produit dans ce manuel.

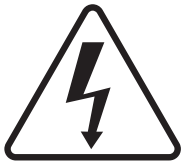
Warnungen und Vorsichtshinweise



Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sie vor „gefährlichen Spannungen“ im Inneren des Produkts warnt.

Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.

Advertencias y Precauciones



Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.

“To prevent damaging the instrument or injuring yourself, it is absolutely necessary that you understand everything in English, above all, technical terms, before operating the instrument. Otherwise, it is necessary for you to receive complete instruction from someone qualified who understands both the instrument and English very well.”

“Um eine Beschädigung des Gerätes oder eine Gefährdung des Anwenders zu vermeiden ist es notwendig, daß dieser vollstandig die englische Sprache und die technischen Bezeichnungen beherrscht. Oder der Anwender muß von einer Person eingeübt werden, die bereits vorher dieses Gerät bedienst hat.”

“Pour empêcher dommage à l’instrument ou blesser vous-même, il faut absolument que vous compreniez tout en anglais, surtout les termes techniques, avant d’actionner l’instrument. Autrement, il faut que vous receviez l’instruction parfaite d’une personne très compétente qui comprend bien les deux l’instrument et anglais.”

“Para prevenir cualquier daño en el instrumento o en el operador, es necesario que el usuario comprenda perfectamente el lenguaje inglés y las términos técnicos intrínsecos, o bien ser formado por una persona que haya trabajado ya previamente con este instrumento.”

“For a forhindre skade på instrumentet eller operatøren er det nødvendig at brukeren har full forståelse for det engelske sprak og tekniske uttrykk Ellers må brukeren få opplæring av en person, som kan engelsk, for instrumentet tas i bruk.”

“För att förhindra skade på instrumentet eller operatören, år det nötvändigt att användaren har fullständiga kunskaper i det engelska språket och dess tekniska termer, eller utbildas av en person, som tidigare brukat instrumentet.”

“For at undgå skade på produktet eller på brugeren er det nødvendigt at brugeren til fulde forstår det engelske sprog for at forstå den tekniske formulering i den engelske manual. I modsat fald skal brugeren modtage træning, inden apparatet tages I drift.”

Laitteelle tai käyttäjälle aiheutuvien vahinkojen välttämiseksi on tärkeää, että käyttäjä hallitsee englannin kielen ja englantilaiset tekniset termit tai on saanut käyttöopastuksen englantia osaavalta henkilöltä.

“Per evitare danni allo struménto od incidenti all’operatore, é necessario che l’utilizzatore abbia una completa conoscensza della lingua inglese oppure che venga istruita da una persona che abbia utilizzato precedentemente questo strumento.”

“Para impedir qualquer dano no aparelho ou ferimentos parao operador, é necessario que o utilizador tenha um conhecimento completo da lingua inglesa e dos respectivos termos técnicos, ou seja, treinado por uma pessoa que tenha esse conhecimento, antes de operar com este aparelho.”

“Για την αποφυγη βλαβης του οργανου ‘η τραυματισμου του χρηστη, ειναι απαραιτητο ο χρηστης να γνωριζει καλα την αγγλικα γλωσσα καθως και τους σχετικους τεχνικους ορους, η να εκπαιδευτει απο ατομο το οποιο εχει προνφουμενως εργαστει πανω στο οργανο αυτο.”

С цел да избегне повреда на апаратурата или нараняване на оператора е необходимо клиента добре да владее английски език и техчническата терминолгия, която е използувана в описанието или да бъде обучен от лице, което е вече работило с такъв апарат.

Figyelmeztetés! A készülék meghibásodásának valamint a kezelö sérülésének megelözése érdekében a felhasználónak feltétlenül értenie kell az angol nyelvet, ezen belül a müszaki kifejezéseket, vagy pedig a használatba vételt megelözöen a készülék kezelésében már gyakarlott személy által történö betanitás szükséges!

- EXPLOSION WARNING -

WARNING
Teledyne Isco D Series Pumps, SFX 2-10 and SFX 220 Extractors are NOT EXPLOSION PROOF.

Teledyne Isco SFX System and D Series Syringe Pump Safety Note when using a flammable fluid

The Teledyne Isco SFX system and syringe pumps must be placed within a properly operating vent hood (fume cupboard), when using ethane or any other flammable gas. Ensure that all SFE tubing connections are completely free of any gas leaks by performing the leak test using CO_2 (detailed in Section 2 of the D Series pump manual, Section 5 of the SFX 2-10 manual and Section 6 of the SFX 2-10, 220, and SFX 3560 manual). There must absolutely be **NO** gas leaks present before introducing the flammable gas. In a temperature-stable, leak-free system, the flow rate, as registered by the pump, should settle to a value below 0.01 ml/min after 15, minutes during a static extraction.

Important: When using a Teledyne Isco extractor (either SFX 2-10, SFX 220, SFX 3560) be absolutely sure the built-in venting fan (a brushless motor) is operating properly.

The Teledyne Isco D Series Syringe Pumps and the SFX units, use *brush-type* drive motors. Minor modifications to the pumps may render them safer, especially in the rare event of catastrophic piston seal failure. **However, these modifications will not make these pumps explosion proof.**

- Remove the front and back cylinder covers located on the ball screw tower. This will allow any escaped gas to quickly dissipate away from the pump cylinder area and to reduce the amount entering the motor compartment.
- Seal the syringe pump motor compartment with tape and purge it with a continuous flow of nitrogen (N_2) gas. This will also reduce the possibility of accumulating an explosive mixture around the motor and relays.
- For further information, telephone Teledyne Isco at (800)775-2965, or fax (402)465-3085 to consult the Teledyne Isco Service Department.

USE THE Teledyne Isco SFE SYSTEM AND SYRINGE PUMPS IN THESE POTENTIALLY HAZARDOUS APPLICATIONS AT YOUR OWN RISK!

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- AVERTISSEMENT D'EXPLOSION -

AVERTISSEMENT

Les pompes de Série 'D' Teledyne Isco et l'extracteur SFX 2-10, SFX 220, et SFX 3560 ne sont pas à l'épreuve d'explosion!

Remarque de sûreté concernant l'usage d'un fluide inflammable avec les pompes à seringue d'Isco Série 'D' et le système SFX.

Le système SFX et pompes à seringue Teledyne Isco doivent être placées à l'intérieur d'une hotte chimique fonctionnelle, quand vous utilisez éthane C_2H_6, ou tout autre gaz inflammable. Assurez-vous que toute la tuyauterie SFE est complètement scellée avec aucune fuite de gaz en exécutant une épreuve de fuite en utilisant du CO_2. (Cette méthode est détaillée à la partie 2 du manuel de la pompe Série 'D'et à la partie 2 du manuel SFX 2-10, SFX 220, et 3560.) Il faut absolument qu'il n'y ait aucune fuite de gaz avant d'introduire le gaz inflammable au système. À partir d'un système à température stable et sans aucune fuite de gaz, la valeur du flot qui est indiqué par la pompe, devrait se stabiliser à une valeur moins de 0,01 ml/min après 15 minutes, pendant une extraction statique.

Important: Quand vous utilisez un extracteur Teledyne Isco SFX 2-10, SFX 220, et 3560, soyez absolument certain que le ventilateur (du moteur *sans brosses*) fonctionne correctement. Quand vous installez l'extracteur, assurez-vous qu'il y a un espace vide de 15 centimètres au moins entre le mur et l'arrière de l'extracteur pour assurer ventilation adéquate.

Le système SFE et les pompes de série 'D' utilisent les moteurs de courant continu. Ils possédent *des collecteurs et brosses* qui produisent des décharges électriques (étincelles) entre eux quand les moteurs fonctionnent normalement. Ces décharges, aussi bien que celles qui sont produites aux contacts des relais pourraient faire exploser un mixture d'air et de gaz inflammable. De petites modifications aux pompes peuvent les rendre moins dangereuses, surtout dans le cas rare d'une panne catastrophique du joint d'étanchéité du piston. **Cependant, il n'y a aucune modification qui fera ces pompes à l'épreuve d'explosion!**

- Enlevez les couvercles de devant et d'arrière du cylindre qui sont situés sur la tour de la pompe. Cela permettra au gaz qui s'échappe de dissiper plus rapidement loin de la pompe et réduira aussi la quantité de gaz qui entre dans le compartiment du moteur.
- Scellez le compartiment du moteur de la pompe avec un ruban adhésif et circulez un flot continu d'azote (N_2) à l'intérieur du compartiment. Cela réduira aussi la possibilité d'accumuler une mixture explosive autour du moteur et relais, où se trouvent la première possibilité des étincelles électriques.
- Pour l'information supplémentaire, téléphonez gratuitement (800) 775-2965, ou télécopiez (402) 465-3085 pour consulter le département de service technique.

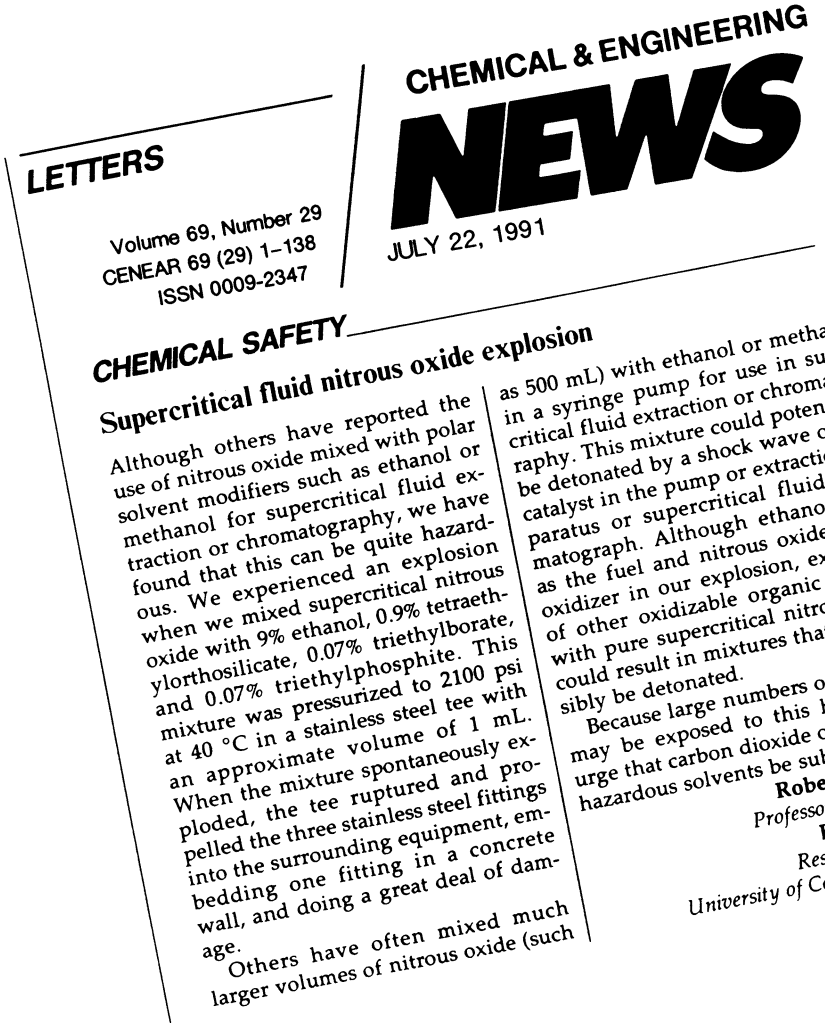
UTILISEZ LE SYSTÈME SFE ET LES POMPES À SERINGUE TELEDYNE ISCO DANS TELLES APPLICATIONS POTENTIELLEMENT HASARDEUSES Á VOS RISQUES ET PÉRILS!

WARNING:
PLEASE READ

At the request of our Supercritical Fluid Extraction laboratory staff, we want our customers to be aware of the potential hazards involved with supercritical fluid extraction. Oxidizing gases, such as nitrous oxide, in contact with organic matrices or flammable modifiers, can detonate under certain conditions. Likewise, flammable fluids, such as methane, under high pressure conditions can present a hazard.

With concern for the safety of our customers, we have designed our extractors to be as safe as possible. However, we do not recommend the use of our instrument with potentially explosive reactions.

The letter below, which appeared in the July 22, 1991 edition of Chemical and Engineering News, is reprinted with permission from Professor Robert E. Sievers and his colleagues at the University of Colorado at Boulder. Even though they were not performing supercritical fluid extraction, it details the problems their lab experienced using nitrous oxide under similar conditions. We add our support for their suggestion to use only carbon dioxide or other less hazardous fluids for supercritical fluid extraction.



LETTERS

CHEMICAL & ENGINEERING NEWS

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JULY 22, 1991

CHEMICAL SAFETY

Supercritical fluid nitrous oxide explosion

Although others have reported the use of nitrous oxide mixed with polar solvent modifiers such as ethanol or methanol for supercritical fluid extraction or chromatography, we have found that this can be quite hazardous. We experienced an explosion when we mixed supercritical nitrous oxide with 9% ethanol, 0.9% tetraethylorthosilicate, 0.07% triethylborate, and 0.07% triethylphosphite. This mixture was pressurized to 2100 psi at 40 °C in a stainless steel tee with an approximate volume of 1 mL. When the mixture spontaneously exploded, the tee ruptured and propelled the three stainless steel fittings into the surrounding equipment, embedding one fitting in a concrete wall, and doing a great deal of damage.

Others have often mixed much larger volumes of nitrous oxide (such as 500 mL) with ethanol or methanol in a syringe pump for use in supercritical fluid extraction or chromatography. This mixture could potentially be detonated by a shock wave or any catalyst in the pump or extraction apparatus or supercritical fluid chromatograph. Although ethanol acted as the fuel and nitrous oxide as the oxidizer in our explosion, extraction of other oxidizable organic samples with pure supercritical nitrous oxide could result in mixtures that can possibly be detonated.

Because large numbers of scientists may be exposed to this hazard, we urge that carbon dioxide or other less hazardous solvents be substituted.

Robert E. Sievers
Professor of Chemistry
Brian Hansen
Research Assistant
University of Colorado, Boulder

CAUTION:
Avoid spills! Liquids associated with this instrument may be classified as carcinogenic, biohazardous, flammable, or radioactive. Should these liquids be used, it is highly recommended that this application be accomplished in an isolated environment designed for these types of materials in accordance with federal state and local regulatory laws and in compliance with your organization's chemical/hygiene plan in the event of a spill.
In all cases, when using Teledyne Isco instrumentation, prudence and common sense must be used.

WARNING:
Pinch point. This symbol warns you that your fingers or hands will sustain serious injury if you place them between the moving parts of the mechanism near this symbol.

WARNING:
Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired; this will increase your risk of injury.

CAUTION:
Liquids associated with this instrument may be classified as carcinogenic, biohazardous, flammable, or radioactive. Should these liquids be used, it is highly recommended that this application be accomplished in an isolated environment designed for these types of materials, in accordance with federal, state, and local regulatory laws, and in compliance with your company's chemical/hygiene plan in the event of a spill.
In all cases, when using Teledyne Isco instrumentation, prudence and common sense must be used.

WARNING:
Team lift. To reduce the risk of injury do not attempt to lift this instrument independently. It is highly recommended that a team be used when lifting this instrument.

AVIS: Éviter de répandre! Les liquides qui sont pompés dans cet instrument peuvent être cancérigènes, hasards biologiques, inflammables, ou radioactifs. Si vous devez utiliser ces liquides hasardeux, il est très recommandé que vous le faites à l'intérieur d'un environnement isolé conçu pour tels liquides. Cet environnement isolé devrait être construit selon les règlements fédéraux, provinciaux, et locaux, aussi que le plan de votre organisation qui concerne l'évènement d'un accident avec les matières hasardeuses. En tout cas, utilisez toujours l'instrumentation d'Isco avec prudence et sens commun.

ATTENTION:
Risque de pincement. Ce symbole vous avertit que les mains ou les doigts recevront une blessure sérieuse si vous les mettez entre les éléments en mouvement du mécanisme près de ce symbole.

ATTENTION:
Éviter les usages hasardeux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie par l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

AVIS:
Les liquides qui sont analysés dans cet instrument peuvent être cancérigènes, hasards biologiques, inflammables, ou radioactifs.
Si vous devez utiliser ces liquides hasardeux, il est très recommandé que vous le faites à l'intérieur d'un environnement isolé conçu pour tels liquides.
Cet environnement isolé devrait être construit selon les règlements fédéraux, provinciaux, et locaux, aussi que le plan de votre organisation qui concerne l'évènement d'un accident avec les matières hasardeuses.
En tout cas, utilisez toujours l'instrumentation d'Isco avec prudence et sens commun.

Commonly Ordered Replacement Parts for the D Series Syringe Pumps

Description		Part Number
Cylinder Seals General:		
30D Seal Assembly 0-2068 bar		60-1249-128
30D Piston Assembly 0-2068 bar		60-1249-129
65D	0-1379 bar	202-9096-08
65DM	0-689.5 bar	202-9096-08
100DX/DM	0-689.5 bar	202-9090-75
260D	0-517.1 bar	202-9091-06
500D	0-258.6 bar	202-9091-56
500HPx	0-344.7 bar	202-9091-56
1000D	0-137.8 bar upper seal	202-9990-25
1000D	0-137.8 bar lower seal	202-9990-23
(For more information on seals, refer to Table 2-7.)		
65D/30D		
Inlet/Outlet fittings:		
¼" F250C Gland		209-0164-02
¼" F250C Collar		209-0164-03
¼" F250C Plug		209-0164-05
65DM		
Inlet/Outlet fittings:		
Valco - ⅛" Nut		209-0169-27
⅛" Ferrule		209-0169-41
⅛" Plug		209-0166-80
⅛ – 1⁄16" Tubing Reducer		209-0169-42
100DX/DM and 260D		
Inlet/Outlet fittings:		
Valco - ⅛" Nut		209-0169-27
⅛" Ferrule		209-0094-07
⅛" Plug		209-0166-80
⅛ – 1⁄16" Tubing Reducer		209-0169-42
500D		
Inlet/Outlet fittings:		
⅛" Tubing Connector to ⅛" NPT		209-0161-01
⅛" NPT Plug		209-0168-00
⅛ – 1⁄16" Tubing Reducer		209-0162-00
500 HPx		
Inlet/outlet fittings:		
3⁄8" Tubing Connector to ⅜" NPT		209-016-100
3⁄8" NPT Plug		209-016-813

Commonly Ordered Replacement Parts for the D Series Syringe Pumps

Description	Part Number
1000D	
Inlet/Outlet fittings:	
¼" NPT Plug	209-0168-09
¼" NPT Connector to ¼" tubing	209-1063-36
Stainless Steel Tubing:	
1⁄16" OD × 0.020" ID	004-7300-21
⅛" OD × 0.069" ID	004-7302-22

-NOTICE-

If you have ordered one of the following custom pumps from Teledyne Isco, technical specifications for tubing and fittings listed in this manual do not apply to your system.

Contact the factory for details about your custom pump.

Models:

65HP

260HP

500HP

500HV

500SP

D Series Syringe Pumps

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D Series Syringe Pumps

Section 1 Introduction

1.1 About This Manual

The 65DM, 100DM, 100DX, 260D, and 500D pumps have 1/8" standard Valco ports. Pipe thread fittings of 1/4" diameter are used for the 1000D, 3/8" diameter for the 500HPx, and 1/8" diameter for the 500D. The 65D and 30D use AE F250C high pressure fittings. Because of these differences, the packages, tubing, and options for different models have different part numbers. Additionally, these pumps are typically used for different applications; therefore, optional kits and accessories may differ.

The installation procedures for the different D Series pump models have been combined where applicable, and separated where necessary, for your convenience.

Optional system configurations may require additional kits and/or software. These additional options are described in their respective sections.

This manual contains the following sections:

Section 1 *Introduction*

Section 2 *Fluid System Connections and Accessories*

Section 3 *Basic Programming and Operation*

Section 4 *Gradient Pumping for Pressure, Flow, and Concentration Modes*

Section 5 *Continuous Flow Introduction, Installation, & Operation*

Section 6 *Modifier Addition*

Section 7 *Modbus Configuration*

Section 8 *Serial Interface*

Section 9 *Pump Maintenance, Troubleshooting, and Servicing*

Appendix A *Replacement Parts*

1.2 Specifications

The technical specifications for the D Series Syringe Pumps are detailed in Tables 1-2 through 1-9.

> ☑ ***Note***
>
> Underwriters Laboratories (UL) has certified all Series D Pumps with the exception of the 100 VAC versions.

Table 1-1 30D Technical Specifications	
CYLINDER CAPACITY	30.42 ml
POWER REQUIREMENTS (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 2.8 A maximum 117 ± 12 VAC, 2.4 A maximum 234 ± 23 VAC, 1.2 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 100 cm / 13.59 cm
WEIGHT	PUMP 36.4 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 22 ml/min (for any pressure up to 2068 bar)
FLOW RATE ACCURACY[a]	± 0.5% above 69 bar and above 0.25 ml/min (maximum 1.0 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[b]	± 0.2% 4-20 mA output, ± 0.5% voltage output using the 12 channel output option
DISPLACEMENT RESOLUTION	1.825 nl /step
REFILL TIME	1.05 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 29 ml/min at any pressure from 0 to 2068 bar
PRESSURE RANGE	0.6895 to 2068.4 bar
PRESSURE ACCURACY	± 0.2% of full scale at constant temperature
PRESSURE REPEATABILITY[c]	± 0.05% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.05% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.015% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[d]	0.88 ± 0.02 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Using water at constant pressure and constant temperature above 69 bar and above 0.25 ml/min.

b. The analog output is an optional accessory.

c. Pressure repeatability specification is based on zeroing the pressure transducer before measurement. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.

d. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-2 65D Technical Specifications	
CYLINDER CAPACITY	67.97 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 25 ml/min (for any pressure up to 1379 bar)
FLOW RATE ACCURACY[b]	± 0.3% (maximum 0.25 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	2.55 nl /step
REFILL TIME	1.7 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 40 ml/min at any pressure from 0 to 1379 bar
PRESSURE RANGE	0.6895 to 1379 bar
PRESSURE ACCURACY	± 0.1% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.015% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-3 65DM Technical Specifications	
CYLINDER CAPACITY	67.97 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 45.0 cm / 30.48 cm Height: 103.0 cm / 13.59 cm
WEIGHT	PUMP: 33.2 kg CONTROLLER: 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 30 ml/min (for any pressure up to 689 bar)
FLOW RATE ACCURACY[b]	± 0.3% of setpoint, (maximum 0.25 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	2.55 nl /step
REFILL TIME	1.7 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 40 ml/min at any pressure from 0 to 689 bar
PRESSURE RANGE	0.6895 to 689 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature (± 0.1% FS optional)
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.12% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-4 100DM Technical Specifications	
CYLINDER CAPACITY	102.93 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 25 ml/min (for any pressure up to 689.5 bar)
FLOW RATE ACCURACY[b]	± 0.3% (maximum 0.25 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	4.825 nl /step
REFILL TIME	3.5 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 30 ml/min at any pressure from 0 to 689.5 bar
PRESSURE RANGE	0.6895 to 689.5 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.0.12% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m
NOTES:	

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-5 100DX Technical Specifications	
CYLINDER CAPACITY	102.93 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	0.01 µl/min to 50 ml/min (for any pressure up to 689.5 bar)
FLOW RATE ACCURACY[b]	± 0.3% (maximum 0.25 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	0.01 µl/min (1.0 µl/min in Constant Pressure Mode)
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	9.65 nl /step
REFILL TIME	1.72 minutes
REFILL OR DEPRESSURIZATION RATE	0.01 µl/min to 60 ml/min at any pressure from 0 to 689.5 bar
PRESSURE RANGE	0.6895 to 689.5 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.0.12% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	1.30 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-6 260D Technical Specifications	
CYLINDER CAPACITY	266.05 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 101.09 cm / 13.59 cm
WEIGHT	PUMP 32.8 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-1.
FLOW RATE ACCURACY[b]	± 0.5% (maximum 0.50 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	16.63 nl /step
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 107 ml/min at any pressure from 0 to 517.1 bar
PRESSURE RANGE	0.6895 to 517.1 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.15% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	2.10 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-7 500D Technical Specifications	
CYLINDER CAPACITY	507.38 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT	PUMP 33.25 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-2.
FLOW RATE ACCURACY[b]	± 0.5% (maximum 1.0 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[c]	± 1% of selected range
DISPLACEMENT RESOLUTION	31.71 nl /step
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 204 ml/min at any pressure from 0 to 258.6 bar
PRESSURE RANGE	0.6895 to 258.6 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[d]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.15% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[e]	4.00 ± 0.020 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

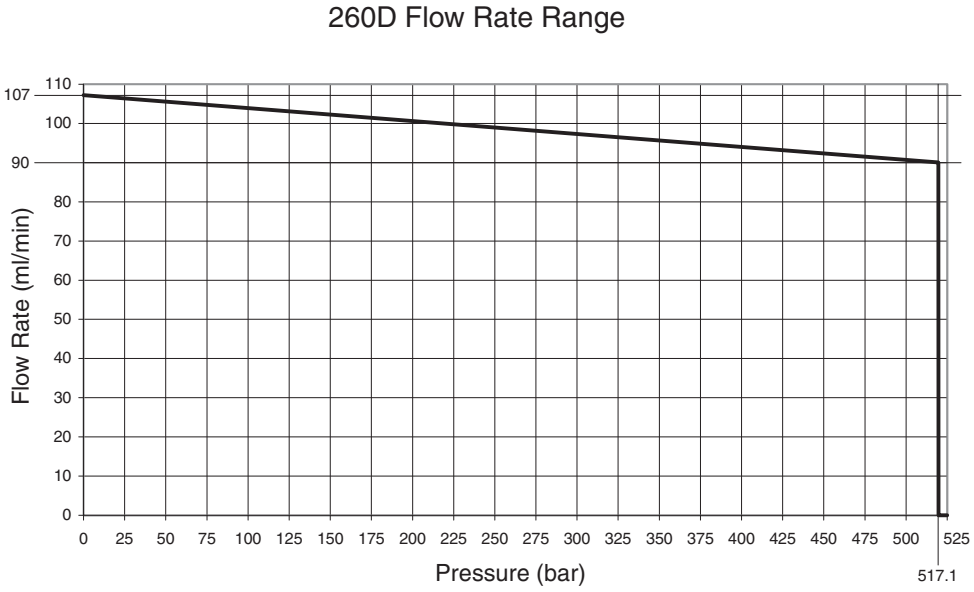
a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. Using water at 137.9 bar and a temperature controlled environment at 30°C.
c. The analog output is an optional accessory.
d. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
e. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

Table 1-8 500HPx Technical Specifications	
CYLINDER CAPACITY	507.38 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 5A maximum 117 ± 12 VAC, 5A maximum 234 ± 23 VAC, 2.5A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT[b]	PUMP: 42.64 kg CONTROLLER: 2.96 kg
FLOW RATE RANGE	See Figure 1-3.
FLOW RATE ACCURACY[c]	± 0.5% (maximum 1.0 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[d]	± 1% of selected range
DISPLACEMENT RESOLUTION	25.36 nl /step
REFILL TIME	1.25 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 408 ml/min at any pressure from 0 to 344.7 bar
PRESSURE RANGE	0.6895 to 344.7 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[e]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.15% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[f]	10.45 ± 0.65 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. A team lift is recommended when moving this instrument.
c. Using water at 137.9 bar and a temperature controlled environment at 30°C.
d. The analog output is an optional accessory.
e. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
f. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.

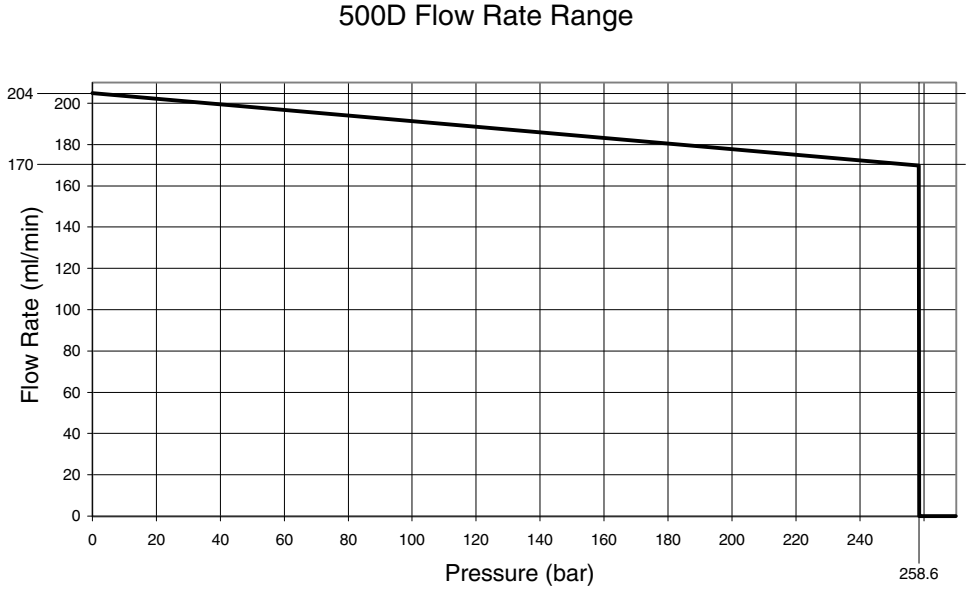
Table 1-9 1000D Technical Specifications	
CYLINDER CAPACITY	1015.0 ml
POWER REQUIREMENTS[a] (Mains voltage line cord is a "Disconnect Device")	100 ± 10 VAC, 1.5 A maximum 117 ± 12 VAC, 1.5 A maximum 234 ± 23 VAC, 0.75 A maximum } Factory Set
LINE FREQUENCY	50 or 60 Hz
LINE VOLTAGE NOISE TOLERANCE	1.7 × nominal rms line voltage, 10 µsecond pulses, any phase angle, random or repetitive
DIMENSIONS	PUMP / CONTROLLER Width: 27.18 cm / 27.18 cm Depth: 46.74 cm / 30.48 cm Height: 102.36 cm / 13.59 cm
WEIGHT[b]	PUMP 38.5 kg / CONTROLLER 2.96 kg
FLOW RATE RANGE	See Figure 1-4.
FLOW RATE ACCURACY[c]	± 0.5% (maximum 1.5 µl/min seal leakage)
FLOW RATE DISPLAY RESOLUTION	1.0 µl/min
ANALOG OUTPUT ACCURACY[d]	± 1% of selected range
DISPLACEMENT RESOLUTION	25.38 nl /step
REFILL TIME	2.5 minutes
REFILL OR DEPRESSURIZATION RATE	1.0 µl/min to 408 ml/min at any pressure from 0 to 137.9 bar
PRESSURE RANGE	0.6895 to 137.9 bar
PRESSURE ACCURACY	± 0.5% of full scale at constant temperature
PRESSURE REPEATABILITY[e]	± 0.5% of full scale within 48 hours at constant temperature
ZERO PRESSURE DRIFT	± 0.25% of full scale within 48 hours at constant temperature
PRESSURE DISPLAY RESOLUTION	6.895 kPa
AMBIENT TEMPERATURE RANGE	5 to 40°C
TEMPERATURE DRIFT	± 0.12% of full scale/°C
HUMIDITY	95% maximum
DEAD (HEADSPACE) VOLUME[f]	11.0 ± 0.7 ml
POLLUTION DEGREE	2
INSTALLATION CATEGORY	II
MAXIMUM ALTITUDE	2000 m

a. Underwriters Laboratories (UL) has certified all D Series Pumps with the exception of the 100 VAC versions.
b. A team lift is recommended when moving this instrument.
c. Using water at 137.9 bar and a temperature controlled environment at 30°C.
d. The analog output is an optional accessory.
e. Pressure repeatability specification is based upon re-zeroing pressure transducer every 48 hours. Refer to sub-section ZERO PRESS in Section 3 of the manual for re-zeroing procedure.
f. Volume in and above the piston seal, head clearance at automatic shutoff, and inlet and outlet ports to the fittings.



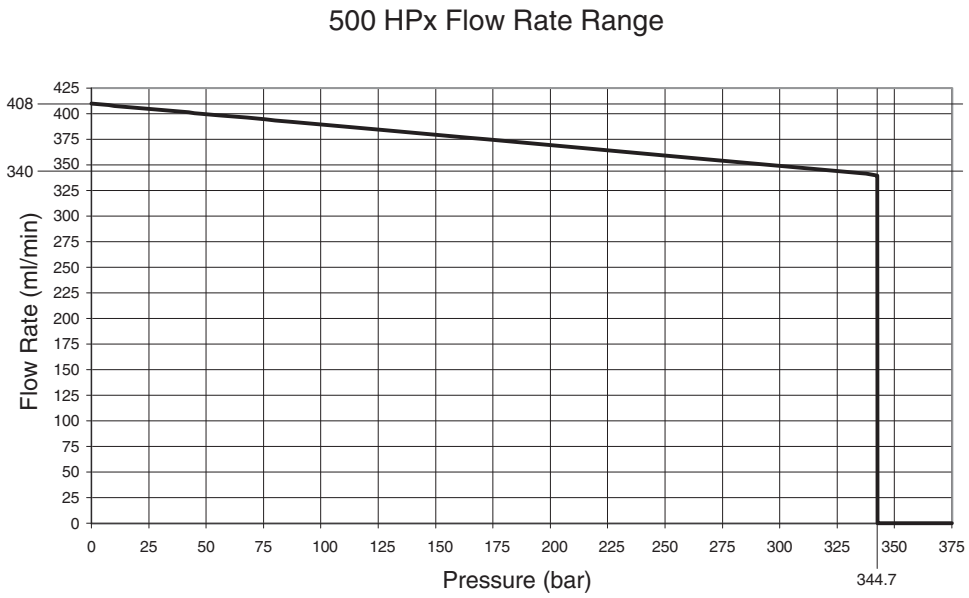
Flow Rate (ml/min)	Max. Pressure (bar)
0.001 to 90	517.1
90 to 107	(107.23 ml/min – flow rate) × 30

Figure 1-1 260D flow rate range



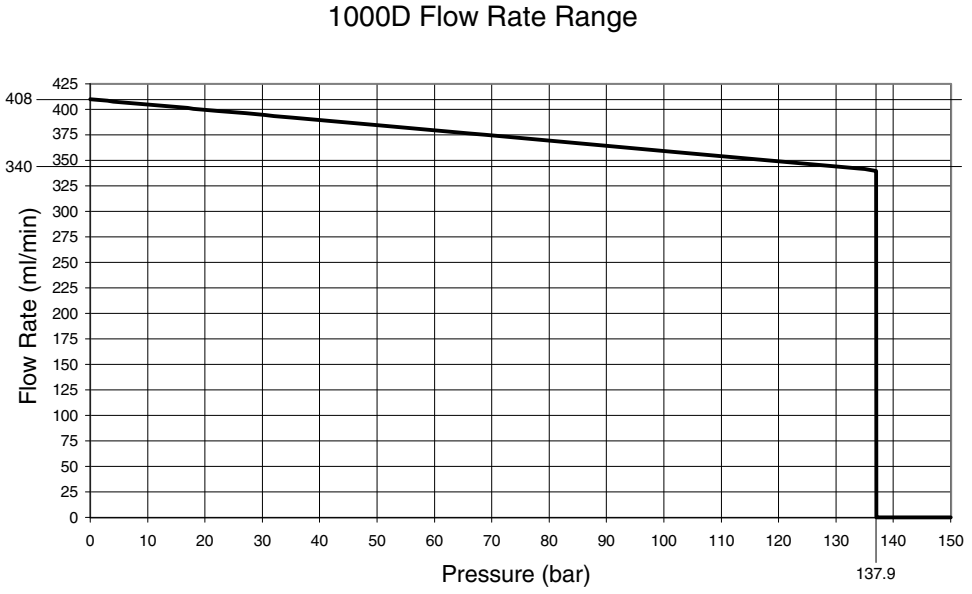
Flow Rate (ml/min)	Max. Pressure (bar)
0.001 to 170	258.6
170 to 204	(204.9 ml/min – flow rate) × 7.4

Figure 1-2 500D flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0.001 to 340	344.7
340 to 408	(409.8 ml/min – flow rate) × 4.985

Figure 1-3 500 HPx flow rate range



Flow Rate (ml/min)	Max. Pressure (bar)
0.001 to 340	137.9
340 to 408	(409.8 ml/min – flow rate) × 1.9756

Figure 1-4 1000D flow rate range

1.3 Unpacking

Teledyne Isco
Customer Service Dept.
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail:
IscoInfo@teledyne.com

After removing the pump, controller, and accessories from the shipping carton, examine them for signs of shipping damage. Be sure no internal parts have shaken loose in transit. If there is any shipping damage, file a claim with the delivering carrier immediately.

Compare the contents of the boxes with the enclosed packing slip. If there are shortages, contact Teledyne Isco immediately.

1.4 Controls and Indicators

The pump controller regulates all pumping functions. It is designed to sit on top of the pump base, but may be located elsewhere, according to safety and convenience. Programming and setup are performed using the keypad on the front panel. The controller front panel is shown in Figure 1-5 and described in Table 1-10. Table 1-11 explains the key functions.

The rear panel of the pump controller contains several input and output connectors, explained in Table 1-12, and shown in Figure 1-6.

The only operational control on the pump itself is the power switch, shown in Figure 1-8. The rear panel has several connectors, described in Table 1-13, and shown in Figure 1-7.

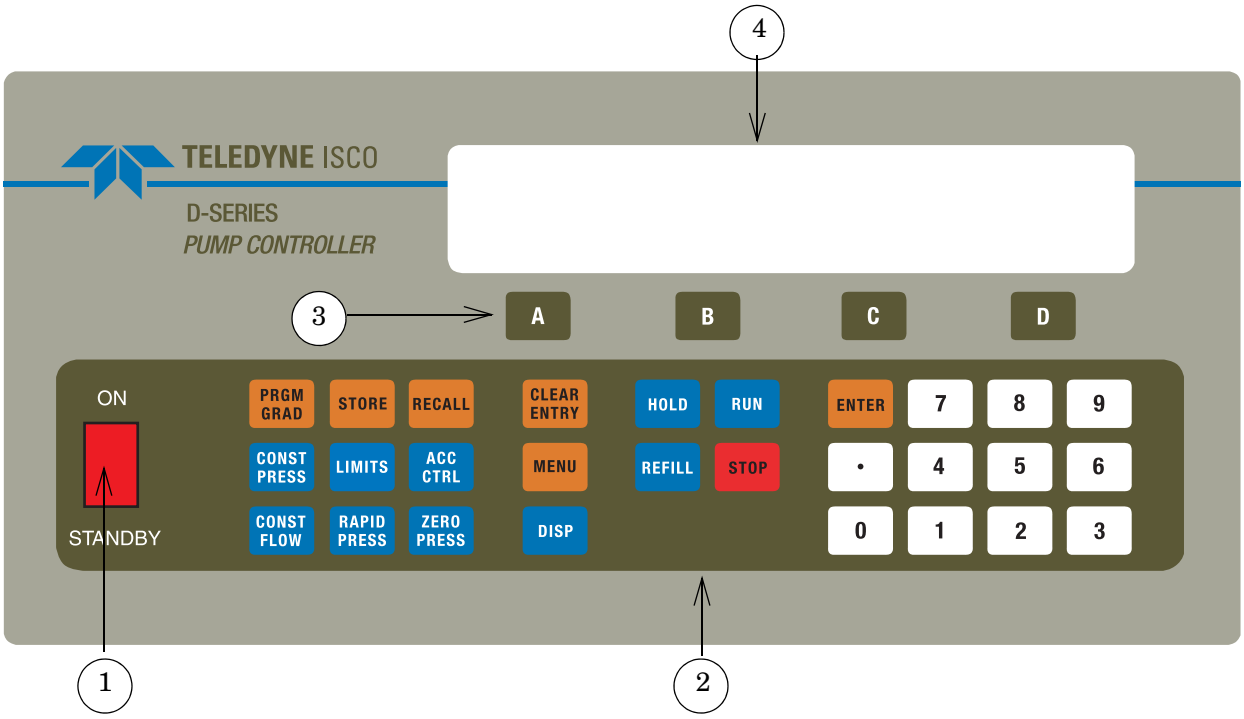


Figure 1-5 Pump controller key functions

Table 1-10 Pump Controller Front Panel Label

Item No. on Figure 1-5	Connector	Description
1	On/Standby switch	Turns instrument off and on. (Does not disconnect power.)
2	Programming keypad	Used to program controller.
3	Softkeys	Labeled A, B, C, and D; used to select menu items displayed directly above them.
4	Liquid crystal display	40 Characters × 4 line.

Table 1-11 Pump Controller Key Functions

Key	Description
ON/STANDBY	Two-position toggle switch turns controller on and activates drive motor to maintain position. Standby disables the drive motor and halts the controlling processor.
A, B, C, D	Softkeys; used to select displayed options.
PRGM GRAD	Program gradient: Puts pump in gradient mode and accesses the soft-key driven gradient programming.
CONST PRESS	Constant pressure: Puts pump in constant pressure mode.
CONST FLOW	Constant flow: Puts pump in constant flow rate mode.
STORE	Stores the current program in nonvolatile memory and exits programming mode.
LIMITS	Displays and allows changes to the maximum and minimum pressure and flow rate limits.
RAPID PRESS	Rapid pressure: Allows rapid pressurization to the stable pressure point and then switches automatically to constant flow. (Available in constant flow mode only.) NOTE: This feature is automatic, *i.e.* RAPID PRESS is pressed only once and the user does not enter a pressure; although, entering a target pressure may speed equilibration.
RECALL	Replaces the current program with one recalled from nonvolatile memory.
ACC CTRL	Accessory control: Manually operates accessories such as valves.
ZERO PRESS	Zero pressure: Sets pressure display to zero. Active only from -750 to +750 psi.
CLEAR ENTRY	Clear the last digit entered from the numeric key.
MENU	Accesses software to set operational modes, units, and other optional parameters.
DISP	Activates dispense mode (refer to Section 3.10.3).
HOLD	Freezes the program clock. The unit will continue at the current gradient parameters.
REFILL	Turns on pump drive motor to move piston downward at a rate previously programmed.
RUN	Turns on pump drive motor to move piston upward in a previously programmed mode, such as “CONSTANT FLOW” or “CONSTANT PRESSURE.”
STOP	Stops the drive motor.
ENTER	Enters selected values to memory.
NUMBER KEYS	These keys are used to make menu selections and enter values when setting parameters.

☑ *Note*

A more in-depth explanation of the keypad is provided in Section 3 *Basic Programming and Operation*, under Section 3.8 *Front Panel Keys*.

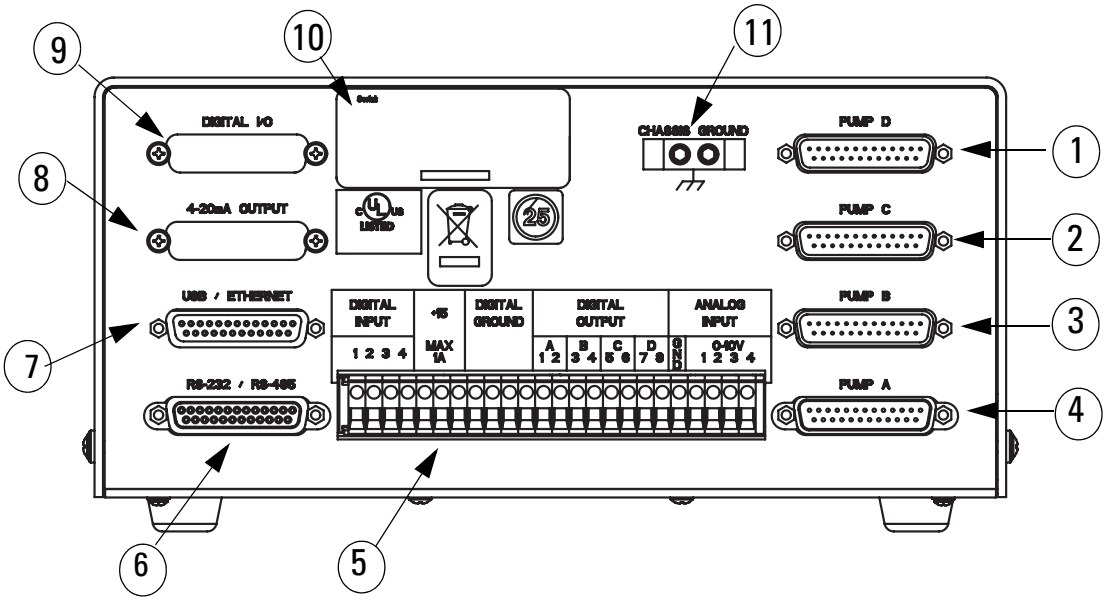


Figure 1-6 Pump controller rear panel connectors

Table 1-12 Pump Controller Rear Panel Connectors

Item No. on Figure 1-6	Connector	Description
1	PUMP D	This connector is only used during multiple pump operation. The control cable from the rear panel of the **fourth** pump is attached to this connector.
2	PUMP C	This connector is only used during multiple pump operation. The control cable from the rear panel of the **third** pump is attached to this connector.
3	PUMP B	This connector is only used during multiple pump operation. The control cable from the rear panel of the **second** pump is attached to this connector.
4	PUMP A	This plug connects the control cable from the pump rear panel. This connection should be secured with the thumbscrews. **IMPORTANT**: The pump A connector is the only input power connector on the rear panel of the controller. During single pump operation, the pump must be attached to this connector to supply power to the controller. **WARNING** **Do not connect or disconnect the control cable when the pump is connected to the mains voltage.**
5	ACCESSORY	These terminals allow connection of input and output signals (such as analog controls and external RUN/STOP).
6	RS-232/RS-485	This serial port connector may be used with an RS-232 or RS-485 cable to place the pump under remote control. Refer to Section 8 for RS-232 and Section 7 for RS-485 pin connections.
7	USB/ETHERNET [a]	Optional circuit provides USB and Ethernet functionality. Refer to Section 8 for USB pin connections and Section 7 for Ethernet pin connections

8	4-20mA OUTPUT[a]	Optional circuit provides 4-20mA current loop output and additional digital inputs and outputs.
	ANALOG OUTPUT[a]	Optional circuit provides flow rate and volume outputs. See Section 3.9.
	ELECTRIC VALVES[a]	Optional circuit provides motor drive for valve operation.
	12-CH OUTPUT[a]	Additional circuit provides flow rate, pressure, and volume outputs.
9	DIGITAL I/O[a]	Optional circuit provides additional digital inputs and outputs.
	ANALOG OUTPUT[a]	Optional circuit provides flow rate and volume outputs. See Section 3.9.
10	SERIAL TAG	This tag indicates the serial number of the instrument.
11	CHASSIS GROUND	Ground point for high static or remote controller installations.

a. Connectors based on installed optional circuit board configuration.

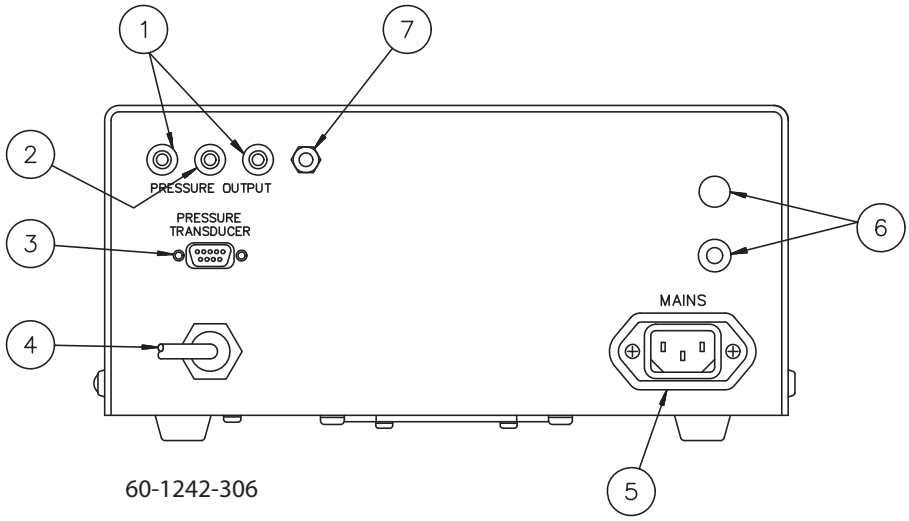


Figure 1-7 Pump rear panel connectors

Table 1-13 Pump Rear Panel Connectors

Item No. on Figure 1-7	Connector	Description
1	Pressure outputs	Two red binding post/banana jacks providing pressure output voltages. Pump — Left Jack VDC/psi — Right Jack VDC/psi 65D — 1.0 V/2000 psi — 0.1 V/2000 psi 30D — 1.0 V/3000 psi — 0.1 V/3000 psi All others — 1.0 V/1000 psi — 0.1 V/1000 psi
2	Ground	A black binding post/banana jack providing a connection to circuit common.
3	Pressure transducer	The pressure transducer cable must be plugged in for the pump to operate.
4	Control cable	This cable connects the pump to the controller.
5	Mains	IEC power connector with EMI filter.

6	External Fuses *	Limits pump current drawn from main power supply. Replace with same type: (“T” time delay fuses) 1 - 2.0 Amp for 100/117 volt operation 2 - 1.0 Amp for 234 volt operation For 500HPx Pumps: 1 - 7.5 Amp for 100 volt operation 1 - 6.25 Amp for 117 volt operation 2 - 3.2 Amp for 234 volt operation For 30D Pumps: 1 - 3.2 Amp for 100/117 volt operation 2 - 1.6 Amp for 234 volt operation To remove, rotate cap counterclockwise.
7	Chassis ground	Ground point for high static installations.
*	Internal fuses not replaceable by the operator	F101 4.0 Amp “T” F102, F104 1.5 Amp “T” F103 0.75 Amp “T” For 500HPx/30D F101 6.25 Amp “T”

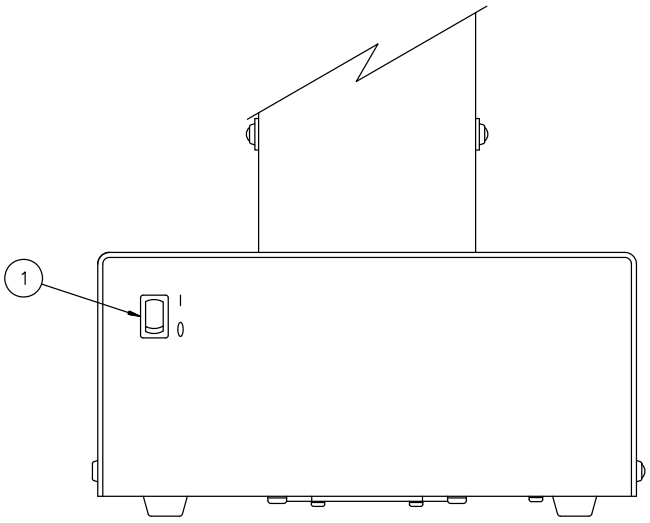


Figure 1-8 Pump front panel controls

Table 1-14 Pump Front Panel

Item No. on Figure 1-8	Connector	Description
1	Mains power switch	Disconnects power from the pump circuits for setup changes, such as connecting the controller. “1” = mains power is applied to the pump circuitry. “0” = mains power is removed from the pump circuitry.

1.5 Electrical Connections

The pump controller may be placed on top of the pump, or wherever safety and convenience dictate. Power is supplied to the pump controller through the control cable.

⚠ CAUTION

All connections between the pump and controller should be made BEFORE the pump is connected to mains power.

1. Connect the pressure transducer cable (which originates from the top of the pump cylinder) to the nine pin sub-D PRESSURE TRANSDUCER connector on the pump rear panel (Figure 1-7). Be sure to tighten the thumbscrews.
2. Connect the control cable (which originates from the first or only pump rear panel) to the PUMP A connector on the rear panel of the controller (Figure 1-6), and tighten the thumbscrews. This cable must be plugged into the PUMP A connector.

☑ *Note*

There are four PUMP connectors on the rear of the controller. Only the PUMP A connector is wired to supply power to the controller; therefore, one pump must be attached to this connector.

3. Check the serial number tag to make sure the voltage rating of the pump is correct.
4. Connect the line cord to the MAINS connector on the back of the pump.

1.5.1 Cabling

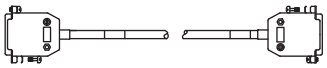
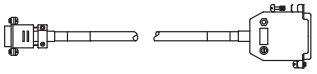
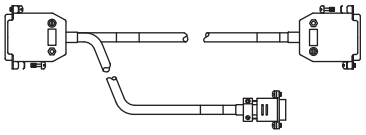
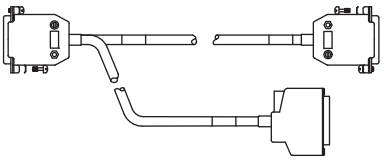
For all systems, connect the control cable of the pump module (Pump A for multiple-pump systems) to the connector labeled PUMP A on the rear panel of the controller. Subsequent pumps in multiple-pump systems can be connected to controller connectors PUMP B, PUMP C, and PUMP D.

☑ *Note*

The transducer cable (refer to Figures 1-9 and 1-10) must be plugged into the PRESSURE TRANSDUCER connector on the rear panel of the pump module for the pump to operate.

Cable part numbers and lengths are listed in the following chart:

USB and TCP/IP use cable package	60-1247-168.	
Pump controller connect cable (see Figure 1-10).	7 ft (2.1m)	(attached to pump)
Pump module transducer cable (see Figure 1-9).	4 ft (1.2m)	
30D/65D Pump module transducer cable	4.5 ft (1.4 m)	69-1244-413

Extension cable for pump controller connect 	Hazloc pumps: 10 ft (3m) 50 ft (15.24m)	 68-1020-505 68-1020-506
	D Series Pumps only: 10 ft (3m) 50 ft (15.2m)	 68-1020-210 68-1020-214
RS232 Cable for computer serial control of a single controller. 9 pin to 25 pin. 	6 ft (1.8m)	480-7996-00
RS232 Cable for computer serial control of two controllers. 9 pin to two 25 pin. 	6 ft (1.8m)	68-1020-198
RS232 Extension cable for computer serial control of three or more controllers. Connects to above cable. 25 pin to two 25 pin. 	6 ft (1.8m)	68-1020-180

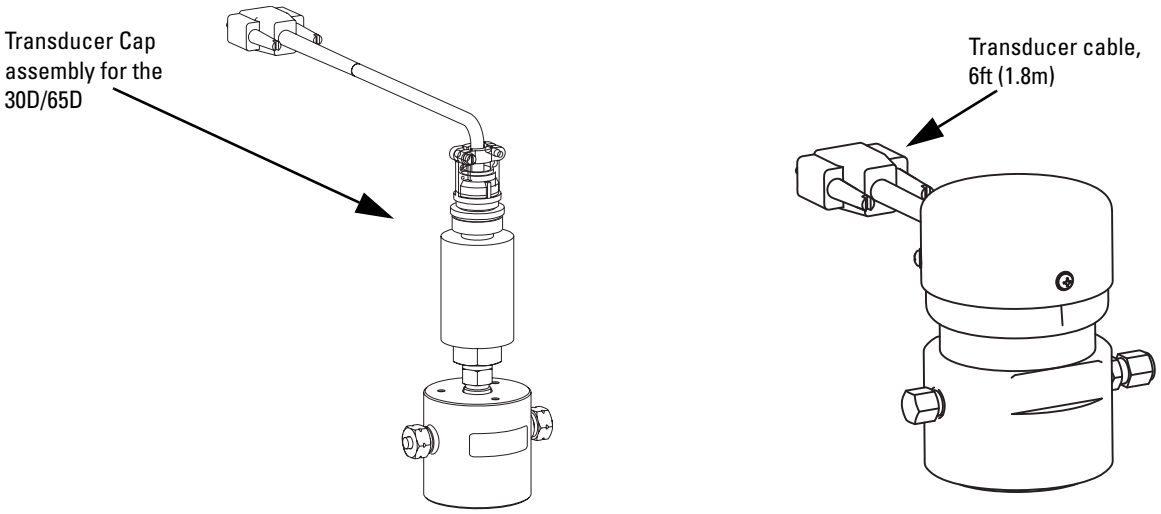


Figure 1-9 Syringe pump cylinder cap: Attach to pressure transducer connector on back of pump.

⚠ CAUTION

The pressure transducer cable length is always 6 feet (1.8m). Never attempt to extend the length of this cable.

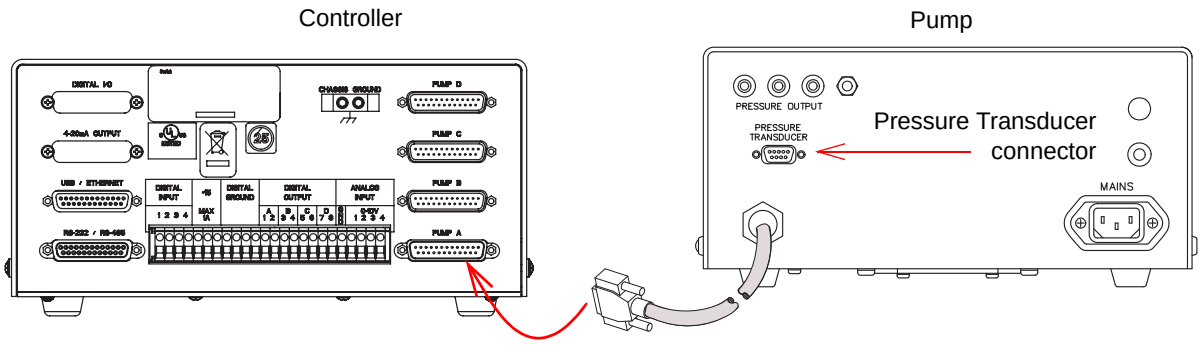


Figure 1-10 Connecting the pump and controller

⚠ CAUTION

Never make any cable connections while the pump is powered ON.

1.6 Preliminary Checkout

After the electrical connections have been completed, follow this brief test of the pump's operation:

☑ *Note*

Preliminary checkout of the pump is performed without fluid in the pump.

If adding a new pump to the controller, a hard and soft reset need to be completed. See Section 9.4.

⚠ CAUTION

Always maintain clearance behind the pump such that the MAINS power cord can be unplugged at any time.

1. Before connecting the line cord, make sure the voltage rating on the serial tag matches your outlet's voltage. Plug in the line cord. Turn the pump power switch ON. Turn the controller ON/STANDBY switch ON.
2. The display will briefly show the software revision on the first line; the pump model(s) connected to the controller.

```
PUMP CONTROLLER ISCO, INC. REV ____
<PUMP MODEL>          CD Jun 16, 2011
SERIAL CHANNEL X,  UNIT ID 6,   Baud = 9600
```

Figure 1-11 Status Screen

3. Check the upper left corner of the controller screen. The current pump mode will appear in a two-letter abbreviation, *e.g.* CF for constant flow. This will be followed by a lowercase letter indicating the current pump, *e.g.* "a" indicates that pump A is the current pump. The current pump is the one for which parameters are being set.
   a. If a pump other than pump A is currently selected:

      In the lower right corner of the screen, directly over softkey D, are the words "SELECT PUMP."

      Press MENU > 2 > A to select pump A. The display will automatically switch to the run screen, showing "a" in the upper left corner.
4. Press MENU to display Menu 1.

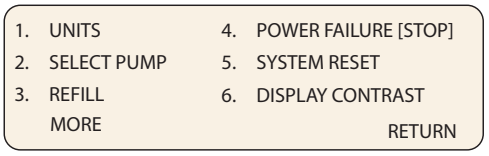


Figure 1-12 Menu 1

5. Press 1 for UNITS.
6. In the Units menu, select the desired units to display for pressure. For example, press 3 to select PSI for the pressure units.
7. In the Units menu, select the desired units to display for flow. For example, press 5 to select ML/MIN for the flow units. The first line of the display will show the selected units.
8. Press PREVIOUS (D) to return to Menu 1.
9. Press RETURN (D), to exit Menu 1.
10. Press CONST FLOW to set the pump mode to constant flow. CFa will be displayed in the upper left corner of the screen.
11. Press FLOW RATE (A). The words ENTER FLOW RATE should flash on the display. Use the numeric keys to enter a flow rate of 10 ml/min and press ENTER.

☑ Note

If you make an error, press CLEAR ENTRY to delete it.

12. Press RUN. Observe the flow rate displayed on the first line. After a few moments, the setpoint and flow rate display should match.
13. Once the setpoint and flow rate match, press STOP.
    a. If three or fewer pumps are connected, you will be prompted to press A to stop pump A, B to stop pump B, C to stop pump C, or D to stop all pumps.

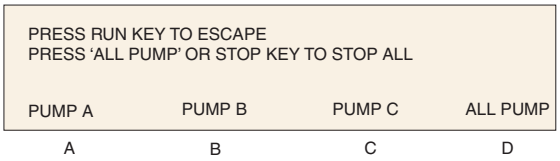


Figure 1-13 Three pump stop menu

b. If four pumps are connected to the controller, you will be prompted to press A to stop pump A, B to stop pump B, C to stop pump C, D to stop pump D, or STOP to stop all pumps.

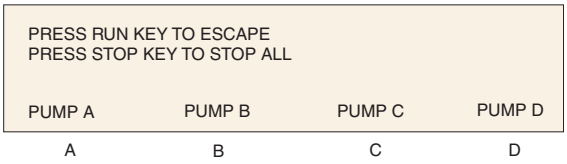


Figure 1-14 Four pump stop menu

If you encountered any problems during the preliminary checkout, please contact the Teledyne Isco Service Department. The number is (800) 775-2965 or (402) 464-0231.

☑ *Note*

In the event of an emergency, turn off the controller switch. This will cause all pumps to immediately stop.

D Series Syringe Pumps

Section 2 Fluid System Connections and Accessories

2.1 Introduction

This section discusses general fluid system connections, and the installation of fluid connection accessories, temperature and pressure control accessories, and optional kits and attachments.

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. USE APPROPRIATE TUBING AND CONNECTIONS AS INSTRUCTED.

☑ *Note*

When operating at flow rates at or below 500 µl/min, it is strongly suggested that an insulating cover or temperature control jacket be installed. See Sections 2.4.1 and 2.4.2.

2.2 Fluid System Connections

All D Series pump models connect similarly, but with varying port sizes. Take care to follow the tips provided to ensure safety and proper operation.

2.2.1 Ports

There are two ports in the pump standard cylinder cap. Either port can serve as the inlet or outlet. As shown in Figure 2-1, you may plug one port and use a single port as both the inlet and outlet.

Standard port information

- 1000D - ¼" NPT
- 65DM, 100DM/DX, 260D - ⅛" Valco
- 500HPx - ⅜" NPT
- 500D - ⅛" NPT
- 65D/30D- ¼" F250C

☑ *Note*

Custom caps are available with different port configurations and sizing. Contact the factory for details.

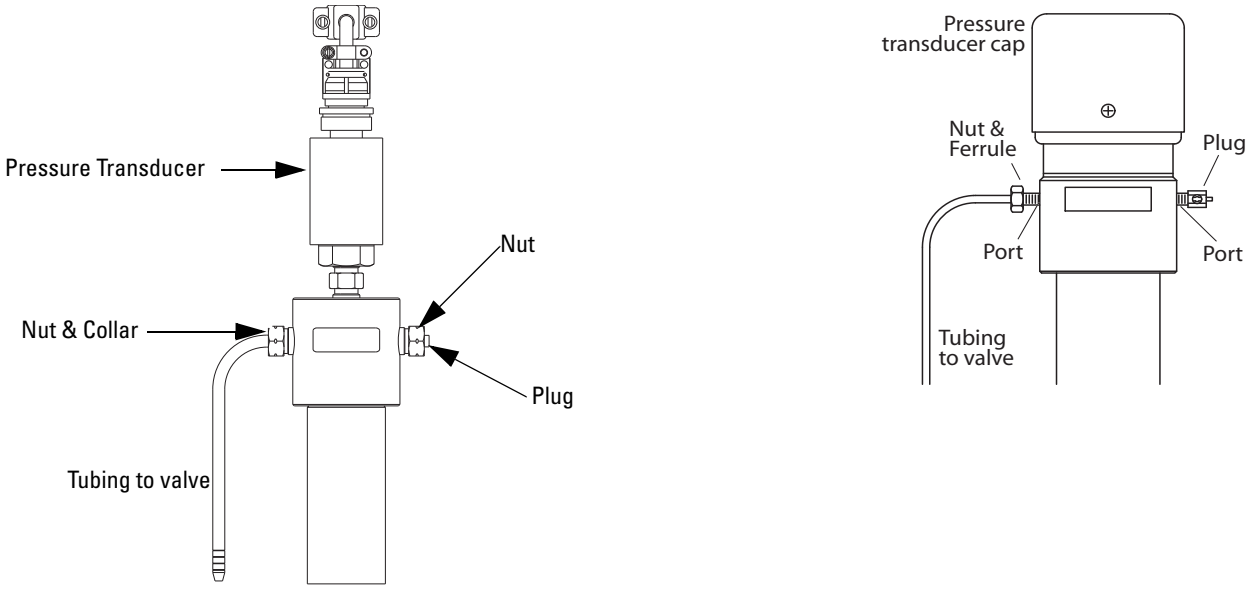


Figure 2-1 Liquid system plumbing connections (30D on Left)

2.2.2 Installation Tips

- Be sure to keep the tubing as straight as possible at the end, as this will make it easier to install the ferrules.
- Be sure to cut the ends of the tubing squarely.
- Do not leave burrs on the ends of the tubing.
- When installing ferrules on the tubing, be sure the tubing extends beyond the ferrule to allow for proper crimping.
- If the connection leaks, retighten fittings.
- Push the tubing completely into the port before tightening the nut.
- When connections are made to the cylinder cap, the pressure reading may be affected. If the pressure no longer reads zero, release all pressure inside the pump, then press ZERO PRESSURE on the front panel of the controller to readjust.

2.2.3 Tubing Requirements

The tubing must be cut squarely to prevent possible problems. Square ends are easier to insert through the ferrule, and will decrease dead volume.

Purchased cut tubing

Electrochemically machined steel tubing should be used throughout the plumbing system. Electrochemically machined tubing has flat, burr-free ends, and is free of cutting residues. This tubing is available pre-cut through many chromatographic supply distributors in assorted lengths.

Cutting the tubing

A less desirable alternative is to purchase a tubing cutter designed to handle steel tubing.

For quick fixes, the tubing may also be cut by hand.

⚠ CAUTION

Wear goggles to perform the following procedure.

Tools required: Fine jewelers file, goggles, and two pairs of pliers

1. Using the jewelers file, score the tubing around its entire circumference.
2. Secure the tubing with pliers on either side of the score line with approximately 1.5mm between each pair of pliers and the score line. Do not squeeze the tubing too tightly, as this will flatten or deform its exterior.
3. Bend the tubing back and forth to crack it at the score line.
4. It may be necessary to deburr the outer tubing ends with the file. Make sure the tubing ends are clean and the inner bore is clear before installing the cut tube.

☑ *Note*

It is often impossible to remove a burr that blocks the inner bore.

2.2.4 Accessory Packages

The accessory packages for all pumps contain fittings that allow you to attach tubing to the pump (refer to Figure 2-1), as well as appropriately sized cylinder seals. Note that the tubing is not included.

Installation

1. Slide first the nut and then the ferrule over the tubing.
2. Push the tubing all the way into the port.
3. Hold the tubing in place and tighten the nut.

Table 2-1 D Series Syringe Pump Accessory Packages

Pump Model	Part Number
1000D	60-1249-103
500D/HPx	60-1249-016
65D	60-1249-024
30D	60-1249-131
260D	60-1249-012
100DM/DX	60-1249-015
65DM	60-1249-028

2.2.5 Installing the 1/16" Fittings (260D, 65DM, and 100DM/DX only)

Refer to Figure 2-1

1. Loosen the 1/16" nut on the adapter until it is held by a few threads.
2. Insert the adapter into the port and finger-tighten the fittings.
3. Retighten the 1/16" nut until it is also finger-tight.
4. Tighten the 1/8" nut with a wrench to crimp the ferrule.
5. Insert the 1/16" tubing through the 1/16" nut until it stops.
6. Tighten the 1/16" nut.

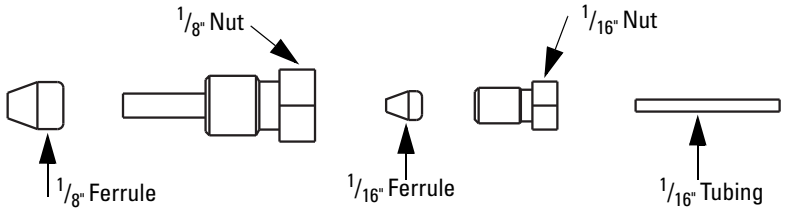


Figure 2-2 1/16" Tubing adapter for 30D/65D pumps

Note

It is recommended that after tightening, the fittings be removed and examined.

F250 Fitting/Connection

Refer to Figure 2-3 for components and fittings for the 30D/65D.

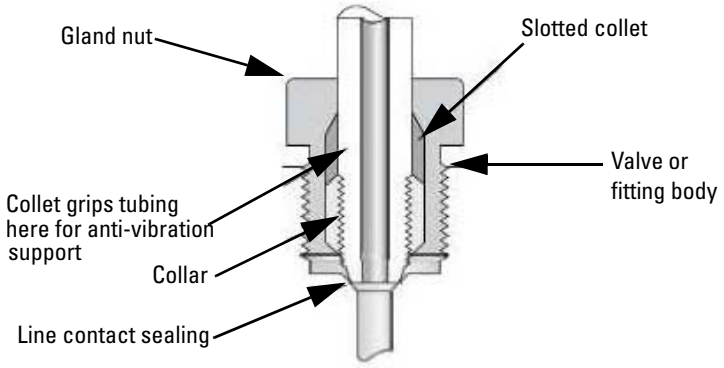


Figure 2-3 30D/65DFitting

2.2.6 Draining Overflow

The drip tray outlet on the pump cylinder provides a means of draining fluid from seal leakage. Use the ¼" ID flexible tubing included with the accessory package to divert the leakage away from the pump.

To install the drain tube, push one end of the tubing over the end of the drip tray outlet, as shown in Figure 2-4.

> **Note**
>
> The 1000D has two drain tube outlets, one for the drip tray, and one for the splash pan, located at the bottom of the pump (see Figure 2-5). The 1000D also includes a wash gland as a standard feature (see the following section for details). The wash gland tubes can also be used as lines for draining away fluid.

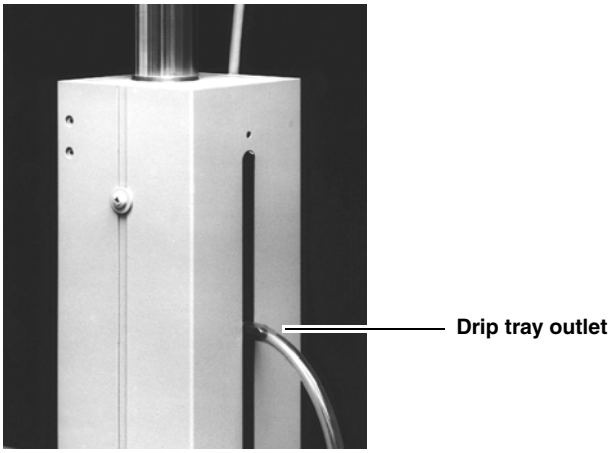


Figure 2-4 Drain tube installation

2.2.7 Cylinder Washing: Wash Gland

A thin film of liquid wets the inside of the cylinder each time the piston travels up the cylinder. The lowest flow rates are conducive to the most abrasive or corrosive pumping environments, as the deposited film remains on the inside of the cylinder wall for the longest time.

The Model 1000D syringe pump is equipped for cylinder washing, with two ⅛" tubes on the back to feed and drain the wash gland, as shown in Figure 2-5 on the following page.

A small pump can be used to deliver the wash fluid through one of the two tubes to rinse the cylinder and seals. The second tube drains the wash fluid to waste. If the system is configured to recirculate the wash fluid, ensure that you change the wash fluid at regular intervals.

Select a wash fluid that will best flush the cylinder of any residue left by the pumped fluid, yet will not damage the seals.

⚠ CAUTION

The pressure in the wash gland and line should NEVER exceed the system pressure or the wash pressure limit as labeled on the pump. Units with a wash pressure limit label can be damaged if the pressure is exceeded.

☑ *Note*

If the primary pump seal fails, the pressure of the delivery fluid will be exerted on the secondary (wash gland) seal. During operation, the wash gland outlet should always be uncapped and routed for either recirculation or drainage.

Detailed information about pumping salt solutions and brines is available in technical bulletin TB04 Pumping Salt Solutions and Brines.

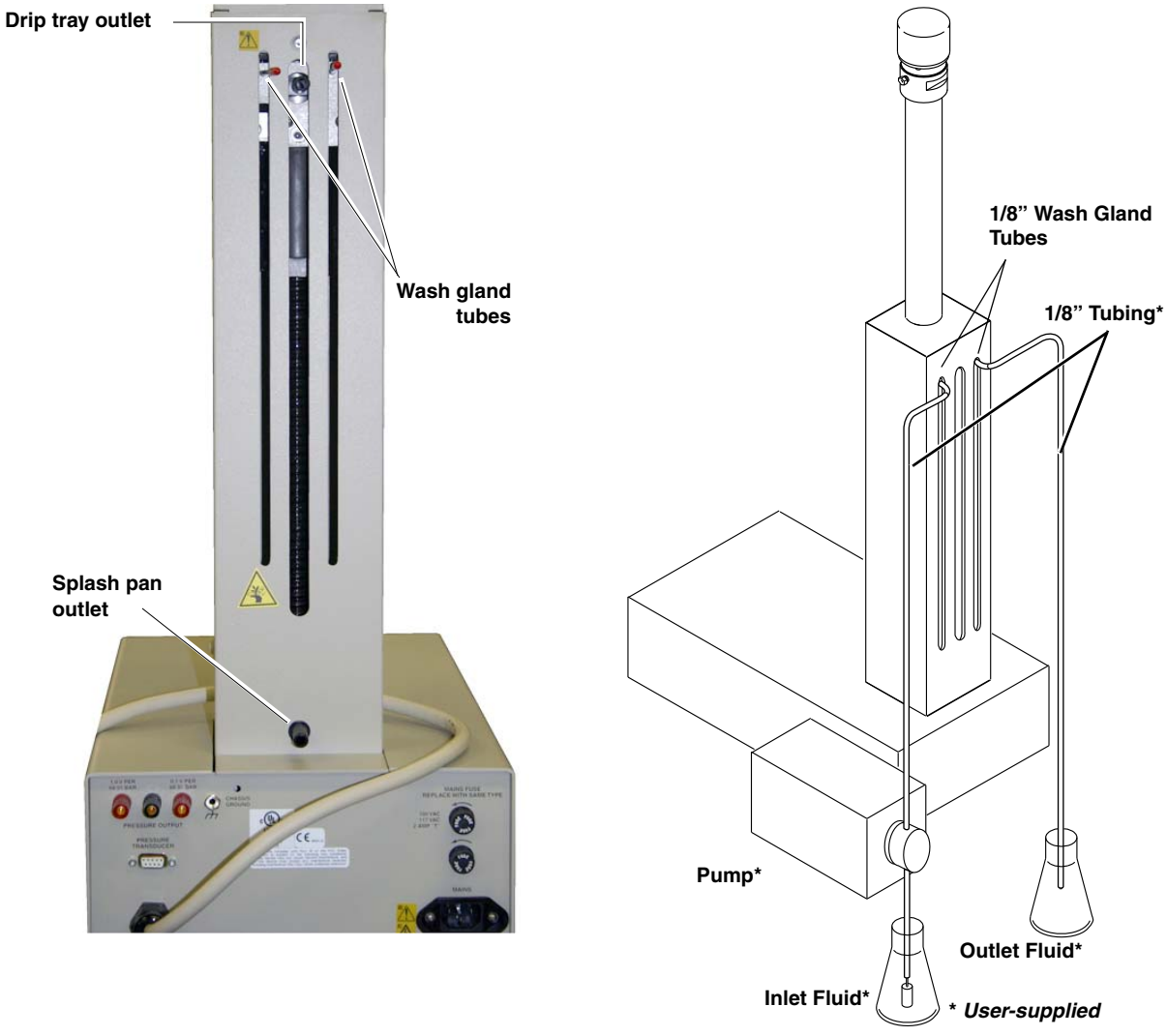


Figure 2-5 Drain tube installation and wash gland connection

Note

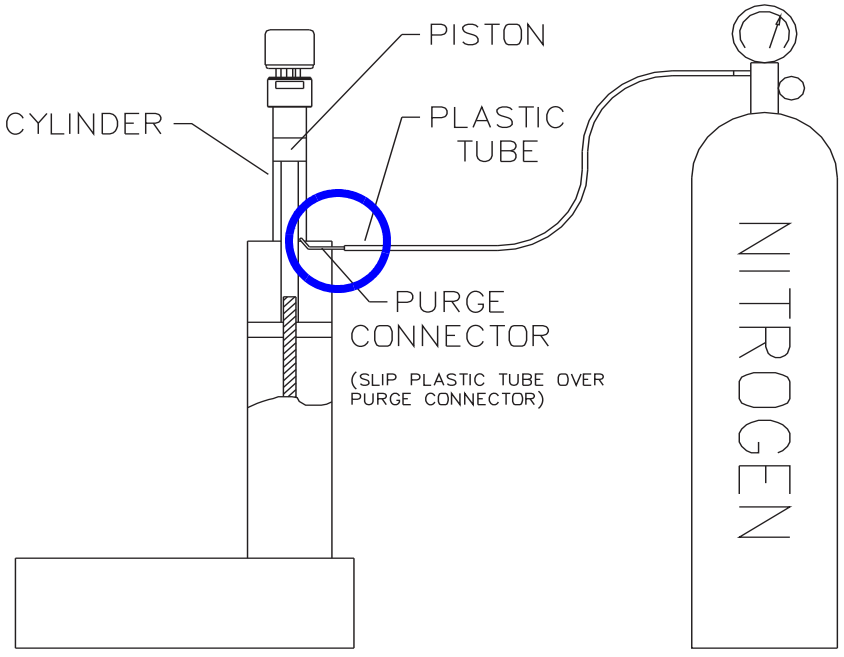
Wash gland options are available for the 500D syringe pump, with 1/16" wash tubes. Contact Teledyne Isco for more information.

2.2.8 Cylinder Washing: Nitrogen Purge

All pumps that do **not** have a wash gland are equipped with a purge connector tube near the top of the pump body. The purge connector enables the pump cylinder beneath the piston to be purged with nitrogen, which can increase useful cylinder life by flushing residue from the system. Figure 2-6 shows a typical connection to the purge tube on the back of the pump.

To purge with nitrogen

1. Attach gas supply by slipping the plastic tube over the purge connector, as shown below.
2. Regulate the nitrogen supply to slightly above atmospheric pressure.



Close-up view of nitrogen purge tube

Figure 2-6 Purge connector installation

2.2.9 Flushing Pumps with External Transducers

When changing pumped liquids in the Model 65D, 30D or other models with external transducers, flush the pump to prevent cross-contamination or difficulties with incompatible fluids.

In comparison to other D-Series pumps, those with external transducers have a greater dead volume space due to transducer and tubing differences. This dead volume space increases the possibility of residual liquid being held in the pump. Also, the external transducer may retain residual liquid. Dead volumes are listed in the specification tables found in Section 1.

To flush the pump, remove the transducer and its tubing from the top of the pump.

⚠ CAUTION

Never immerse the transducer in solvent.

Using nitrogen, blow out any liquid that remains inside the cylinder, transducer port, and tubing.

⚠ WARNING

Liquids expelled by compressed gasses may cause injury. Wear eye protection. Certain liquids also may require other personal protective equipment. Refer to the applicable Material Safety Data Sheet (MSDS) for more information.

2.3 Fluid Connection Accessories

The optional accessories discussed in this section are used to make fluid connections from the pump(s) to another apparatus.

When making fluid connections that use ferrules, be sure to use the ferrules provided in the kit. Push the tubing completely into the connector and finger-tighten. Then tighten with a wrench to clamp the ferrules onto the tubing.

2.3.1 Manual Refill Kit

The optional manual refill kit provides a high pressure, two-way valve that connects to the pump inlet to a fluid reservoir. The kit contains all tubing and hardware necessary for valve installation. Kit components and connections are shown in Figure 2-7.

Kit installation

1. To attach the two-way valve to the pump housing, use the valve spacer block and screws provided.
   a. For the 500D pump, screw the male adapter into the inlet port of the pump.
2. Connect the pre-bent stainless steel tubing from the valve to the pump inlet. Use the nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Connect the PTFE refill tubing (with the filter) to the port of the two-way valve, using the nuts and ferrules supplied.

☑ Note

When connecting to pressurized sources in supercritical fluid applications, use the stainless steel tubing **without** a filter. An in-line filter is contained in the CO_2 connection package (refer to Section 2.3.3).

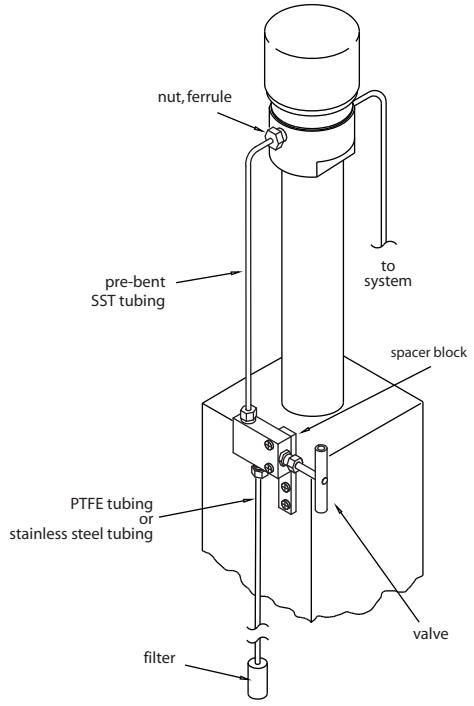


Table 2-2 Manual Refill Kits	
Pump Model	**Part Number**
1000D	68-1247-117
500D	68-1247-083
65DM, 100DM/DX, 260D	68-1247-077
30D	60-1247-180
65D	68-1247-127

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

Figure 2-7 Refill kit installation

2.3.2 Manual Outlet Valve Kit

The optional manual outlet valve kit provides manual control of the pump outlet port by connecting a shutoff valve between the pump and the rest of the system.

Kit installation

1. Attach the two-way valve using the spacer block and pan-head screws.
   a. For the 500D pump, screw the male adapter into the pump outlet.
2. Connect the pre-bent length of stainless steel tubing to the outlet port on the pump using the nut and ferrule. Connect the other end to the top port on the valve using the valve fitting.

☑ Note

For the 500D, this piece of tubing should be cut to the proper length for connection to your system. Due to the wide variety of applications for this model, fittings to connect the tubing to your system are not provided in the kit.

Note

When nuts are torqued to the cylinder cap ports, the pressure reading may be affected. If the pressure no longer reads zero, release the pressure in the cylinder and press ZERO PRESS.

3. Use the valve fittings to attach stainless steel tubing to the top port of the two-way valve.
   a. For models 65DM, 100DM/DX, and 260D, connect the reducing union to the other end of this tubing.
4. Connect the stainless steel tubing between the valve's bottom port and your apparatus. Cut to the desired length.

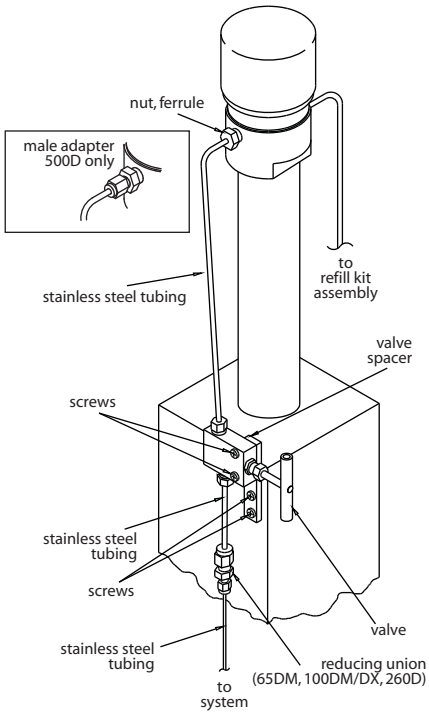


Figure 2-8 Outlet valve package connection

Table 2-3 Manual Outlet Valve Kits

Pump Model	Part Number
1000D	68-1247-118
500D	68-1247-082
65DM, 100DM/DX, 260D	68-1247-078
30D	60-1247-181
65D	68-1247-126

⚠ DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

2.3.3 CO_2 Cylinder Connection Package

For North American gas tank connections, the optional CO_2 connection package is available from Teledyne Isco.

Table 2-4 CO_2 Cylinder Connection Package 68-1247-043

Qty.	Part Number	Description
1	209-0161-63	Reducing connector 1/8" to 1/4"
1	209-0161-16	1/4" × 2 1/2" nipple
1	209-0161-15	0.830-14 nut
1	209-0161-17	PTFE washer
1	209-0161-64	In-line filter assembly

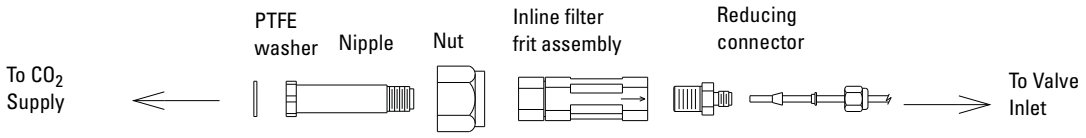


Figure 2-9 CO_2 package installation

2.3.4 In-Line Filter Package

The optional in-line filter package should be used when it is important to filter flow exiting the pump. This package contains a 0.5 µm filter and 1⁄16" tubing.

Note

This filter is not for use at pressures above 6,000 psi (414 bar).

Table 2-5 Optional in-line Filter Package 68-1247-011

Qty.	Part Number	Description
1	60-1243-231	1.5 m stainless steel tubing, 1⁄16" OD × 0.020" ID
1	60-1243-232	0.3 m stainless steel tubing, 1⁄16" OD × 0.020" ID
1	209-9012-17	In-line solvent filter with replacement frit, 0.5 micron filter
5	209-0094-07	Zero volume, 1⁄16" valve nut
5	209-0094-08	Zero volume, 1⁄16" valve ferrule

Installation

1. Attach the reducing adapter from the pump accessory package to the pump outlet, using the nut and ferrule provided. Or, connect to the reducing union of the outlet valve package.
2. Attach the 1⁄16" - 1.5 m length of tubing to the reducing adapter. Cut to the desired length.
3. Then attach the in-line filter to the end of the tubing. The flow direction is indicated on the filter body.
4. Connect the remaining 0.3 m length of tubing between the in-line filter and the receiving device. Cut to the desired length.

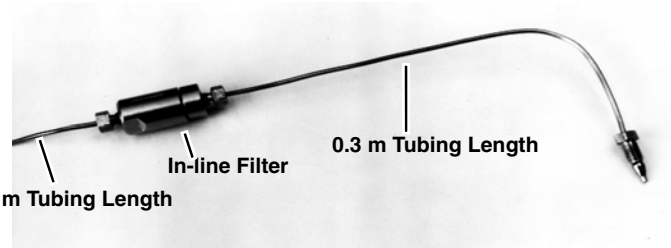


Figure 2-10 In-line filter package

2.4 Temperature and Pressure Controls

Some applications, such as those with very low flows, may require additional measures to maintain steady rates.

2.4.1 Cylinder Insulating Cover

The optional insulating cover can reduce flow noise due to temperature fluctuations and improve pump performance at flow rates under 500 µl/min.

> **Note**
>
> The insulating cover is not available for Models 500HPx and 30D.

Part numbers:

- Insulating cover for 65D
  60-5364-267
- Insulating cover for 65DM, 100DM/DX, and 260D
  68-1247-081
- Insulating cover for 500D
  68-1247-085

The cover consists of two pieces that fit over the cylinder, as shown in Figure 2-11.

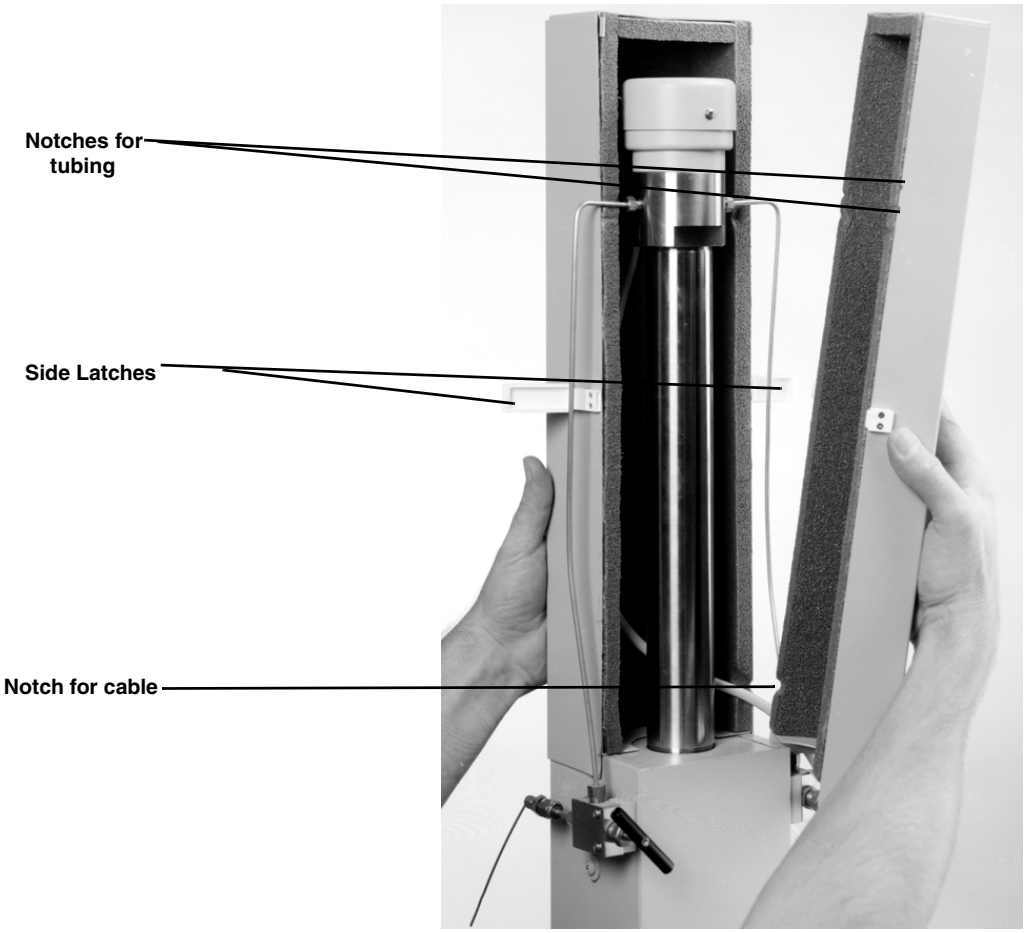


Figure 2-11 Cylinder insulation cover

Notches in the cover provide openings for the inlet and outlet tubing, and for the cable to the pressure transducer.

Installation

1. Install the back cover.
2. Route the cable around tubing through the appropriate tabs.
3. Install the front cover and secure the side latches.

2.4.2 Temperature Control Jacket

The optional cylinder temperature jacket assists in maintaining cylinder temperatures (–30 to 100°C) by circulating liquids, such as water or water/ethylene glycol solution, through the ¼" upper and lower hose connectors.

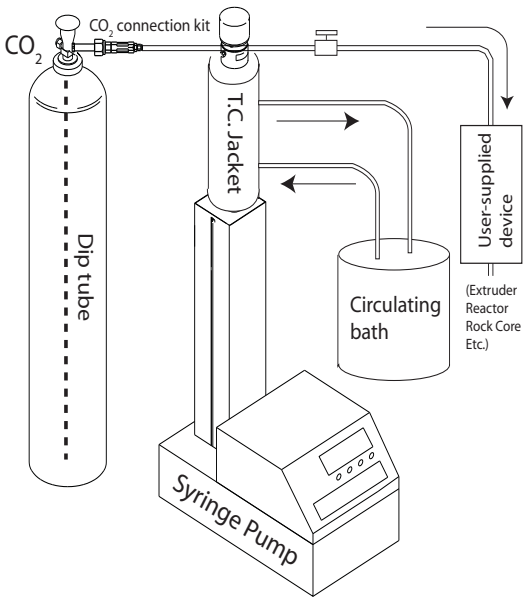


Figure 2-12 System with temperature control jacket installed

The jacket is very useful for SFC applications where cylinder cooling facilitates filling with fluids such as liquid CO_2. The jacket can also be used with a circulating temperature-controlled bath to keep the fluid inside the pump at a constant temperature. This may be necessary when operating at very low flow rates (below 500 µl/min), where temperature fluctuation can cause flow variations.

Table 2-6 Packages and Parts

Item Description	Part Number
Temperature control jacket packages for:	
65D, 65DM,100DM, 100DX, 260D	68-1247-047
30D	68-1267-001
500D, 500HPx	68-1247-057
500SP	68-1247-115
1000D	60-5364-199
Temperature control jacket assembly:	
65DM, 100DM, 100DX, 260D	60-1248-053
30D	60-1268-020
500D, 500HPx	60-1248-099
1000D	60-1248-183
Key $^{3}/_{32}$" socket	490-0031-54
Inlet/outlet connector (2)	209-0161-00
Installation procedure	60-1242-183
O-ring (2):	
100DM, 100DX, 260D	202-2062-23
30D, 65D, 65HP, 500D, 500HPx	202-2062-11
1000D	202-2062-35

☑ Note

For the 30D pump remove the cylinder cap assembly ONLY. Do not remove the cylinder from the cylinder block.

Removing the pump cylinder for 30D

1. Run the pump until the control display shows CYLINDER EMPTY.
2. Remove the fluid fittings from the sides of the pump cap (Figure 2-13).

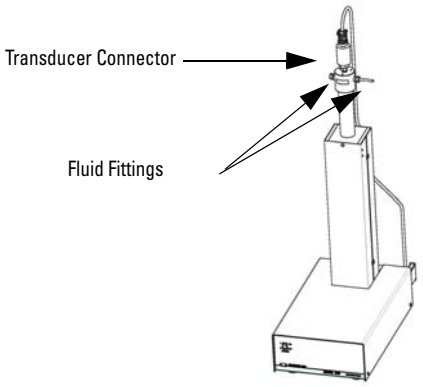


Figure 2-13 Fluid fittings

3. Run the pump until the display shows CYLINDER FULL.

Note

This will fill the pump with air to prevent spills later.

4. Toggle the STANDBY switch on the controller, turning off the controller display.
5. Toggle the POWER switch on the pump to turn off the pump.
6. Unplug the pump from the MAINS power.
7. Disconnect the transducer connector from the top of the transducer (Figure 2-13) and position the cable out of the way.
8. Place the two parts of the CYLINDER HOLDER (part of Wrench Kit 60-1249-132) onto the pump cylinder just below the threads for the cylinder cap (approximately 1/4" (6 mm) below the cylinder cap) (Figure 2-14).

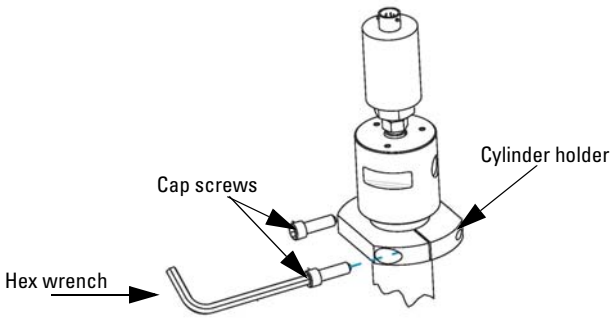


Figure 2-14 Secure screws with the 1/4" hex wrench

Note

If your pump has a cooling jacket installed, assemble the CYLINDER HOLDER below the cooling jacket.

9. Install the 5/16-18 X 1" Cap Screws (supplied with the Wrench Kit) to hold the two parts of the CYLINDER HOLDER in place (Figure 2-14).
10. Tighten the cap screws referred to in step 9 above with the 1/4" hex wrench (supplied with the Wrench Kit) as shown in Figure 2-14, securing the CYLINDER HOLDER to the pump cylinder.
11. Using the two wrenches (supplied with the Wrench Kit) remove the cylinder cap assembly (Figure 2-15).

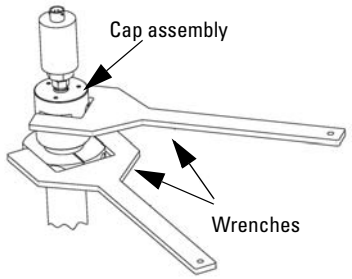


Figure 2-15 Removing the cylinder cap with wrenches

Removing the pump cylinder

Refer to Figure 2-16 on the next page for the following steps.

1. Empty the cylinder.

☑ Note

Be sure the piston is left fully extended.

2. Turn the pump's mains power switch OFF or disconnect the power cord.
3. Remove the pump front cover by loosening the four cover screws (two on each side of the pump).
4. Using a 1/8 Allen wrench, loosen the lock screw located on the front of the cylinder mounting block.
5. Disconnect the transducer cable from the pump and remove the inlet and outlet tubing.
6. Unscrew the cylinder from the cylinder housing.

☑ Note

It may be necessary to use a tubing strap wrench or the Isco wrench package to unscrew the cylinder without marring its outer surface.

7. Lift the cylinder off the piston and push rod.

Installation

1. Install the O-rings in the grooves of the cooling jacket.
2. Lubricate the O-rings with soapy water or a light oil to ease assembly of the cooling jacket onto the cylinder.
3. Slide the cooling jacket onto the cylinder using a twisting motion.

☑ Note

It is important that the cooling jacket be installed with the locking set screw away from the cylinder cap.

⚠ CAUTION

Be careful not to damage the O-rings when pushing them over the threads of the cylinder.

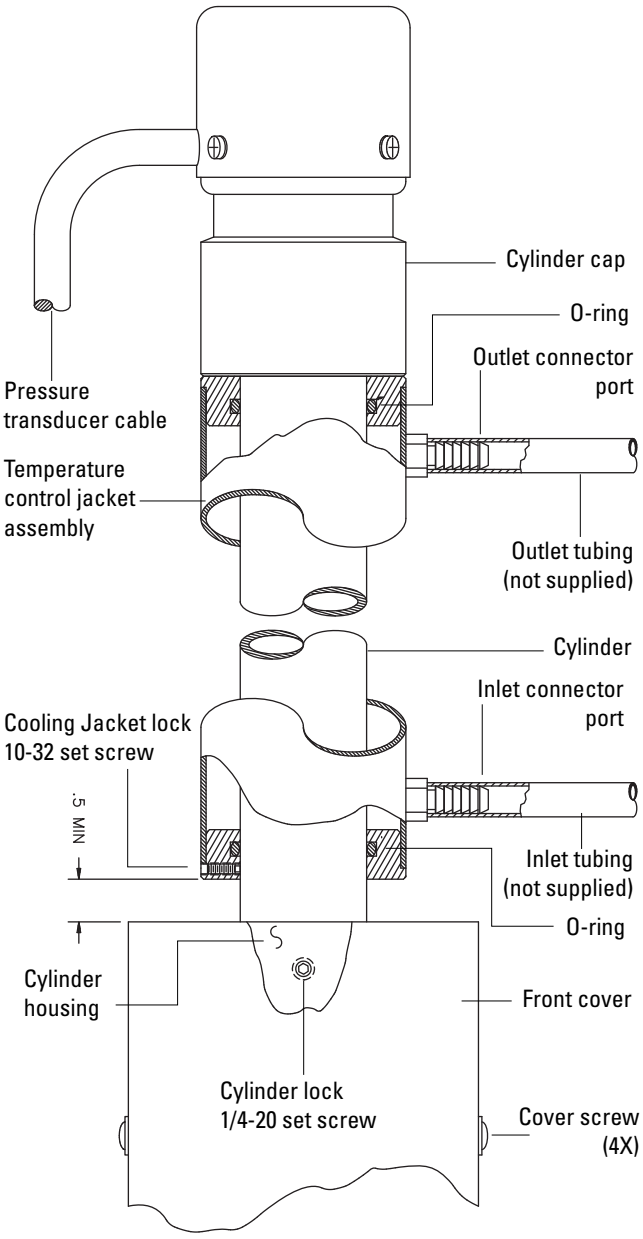


Figure 2-16 Temperature control jacket installation

Reassembling the pump

Refer to Figure 2-16 for the following steps.

1. Lower the cylinder/cooling jacket assembly over the piston and push rod assembly.

Note

To avoid seal damage, ensure that the cylinder is aligned straight with the piston before lowering.

2. Screw the assembly into the cylinder housing until the cylinder is snug against the piston and no longer turns.
3. Unscrew the cylinder a minimum of ½ a turn.
4. Line the inlet and outlet cylinder cap ports up as before. Turn the cooling jacket ports to the desired location and lock the cooling jacket to the cylinder by tightening the set screw.
5. Lock the cylinder by tightening the lock screw.
6. Replace the front cover and adjust both covers so they are flush with the cylinder housing.
7. Reinstall tubing.
8. Reconnect the pump pressure transducer cable.

2.4.3 Back Pressure Regulation

The back pressure regulator option from Teledyne Isco reduces flow noise and improves pump performance at pressures less than 3.5 bar. Two back pressure regulators are available:

- 7 bar, part#209-9012-22
- 5 bar, part#209-9012-21

Fittings to connect the tubing to the regulators are supplied.

DANGER

RISK OF INJURY. THIS EQUIPMENT PRODUCES HAZARDOUS PRESSURES. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS AS NOTED IN THE MANUAL.

Installation

1. Note the arrow on the regulator indicating the fluid direction.
2. Connect your tubing between the pump outlet and the regulator using the supplied fittings.

Figure 2-17 Back pressure regulator

2.5 Seal Options

The pump contains four seals and a wear ring.

Transducer seal – The transducer seal is gold-plated to press into minute gaps between the surfaces of the transducer flange and the shelf of the cylinder cap.

> ☑ ***Note***
>
> The 30D and 65D do not have transducer seals.

Cylinder cap seal – The cylinder cap seal maintains the pressure within the cylinder.

Piston seal – The piston seal maintains the pressure within the cylinder.

Wear ring – The wear ring supports the seal against movement within the cylinder and keeps the piston centered in the cylinder bore.

Wiper seal – The wiper seal cleans the inside of the cylinder. In the model 1000D pump, the wiper seal faces the same direction as the piston seal to prevent leakage of the wash gland fluid.

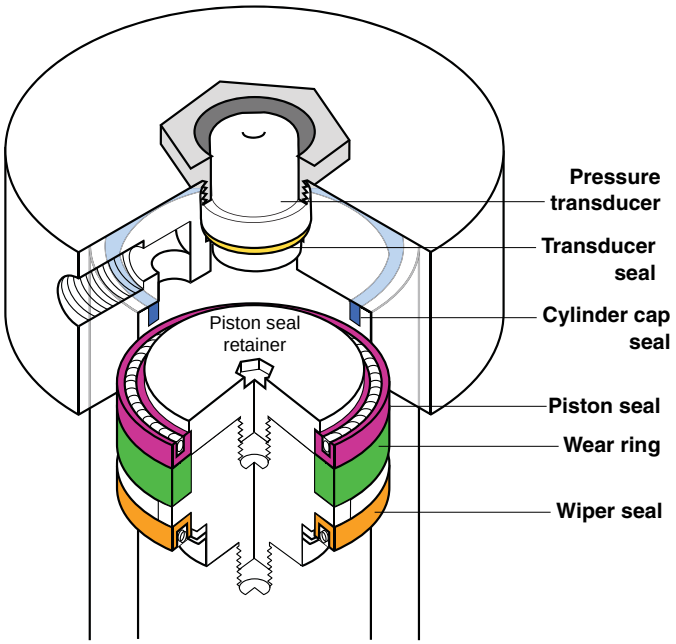


Figure 2-18 Inside the pump cylinder: wetted materials

The standard seals for each pump model satisfy the requirements of most applications, including those that use carbon dioxide, such as SFE. However, certain solvents and/or conditions require special cylinder seals to facilitate the application. Table 2-7 on the following page is provided to help you select the correct seal for your pump and application requirements.

Table 2-7 Seal Selection Chart

Seal Type	Max Pressure	Seal Description	65D/DM	100DX/DM	260D	500D/ 500HPX	1000D
GENERAL/SFE CARBON DIOXIDE	0-689.5 bar	Black, PTFE graphite filled	202-9096-08	202-9090-75	202-9091-06	202-9091-56	upper seal 202-9990-25 lower seal 202-9990-23
	This is our standard seal. It is good for most applications, particularly those using organic solvents, such as: LC, SFC, and SFE.						
HIGH TEMPERATURE	0-689.5 bar	Black, PTFE graphite fiber reinforced high temperature compound		202-9090-76	202-9091-09	202-9093-56	upper seal 202-9990-28 lower seal 202-9990-27
	This seal is best suited for applications which require temperatures between 50°C and 100°C. Its chemical compatibility is similar to that of the general seal.						
LOW PRESSURE	0-137.9 bar	Black, PTFE graphite filled single point contact		202-9092-75	202-9092-06	202-9092-56	N/A
	This seal may provide better sealing at lower pressure. Its chemical compatibility is similar to that of the general seal.						
AQUEOUS	0-689.5 bar	White-translucent, ultra-high molecular weight polyethyl-ene		202-9090-77	202-9094-06	202-9094-56	N/A
	This seal has better wetting properties, making it a good choice for aqueous solutions. It is also the best choice for electrochemical detection. **Note: This seal requires a special break-in procedure before installation. See Section 9.9.2.**						
AMMONIA (NH3) NITRIC ACID	0-275.8 bar	White, virgin PTFE		202-9090-78	202-9091-07	202-9091-57	upper seal 202-9990-26 lower seal 202-9990-24
	This is the only seal recommended for ammonia.						

☑ ***Note***

Call the factory for seal availability for the 30D pump.

D Series Syringe Pumps

Section 3 Basic Programming and Operation

3.1 Introduction

This section will familiarize you with the D Series pump controller and describe operating the pump under each of the various modes: constant flow, constant pressure, dispense, and refill.

Pump setup and operation is regulated by the D Series controller. Operating parameters are entered via the keypad on the front panel of the controller. Operating selections are displayed as menu items on the controller screen or are associated with a dedicated key on the controller keypad. Operating modes such as CONST FLOW, CONST PRESS, DISP, and REFILL all have such dedicated keys.

⚠ WARNING

UL (Underwriter Laboratories) has certified the D Series Controller and Pumps on the basis that explosive chemicals or chemicals that could become explosive under pressure are NOT used. The instruments are not explosion proof. Use extreme caution when pumping hazardous fluids.

3.2 General Controller Information

The following information is intended to familiarize you with controller operation. Once you have become familiar with the keypad and the main menu, you will find it easy to direct the pumping operations required for your applications.

If you make an incorrect entry, press CLEAR ENTRY to delete your last keystroke. If you have entered a programming mode but do not wish to make any changes, press ENTER to keep the current setting, or press softkey D to return to the previous screen.

3.2.1 Rates, Units, and Limits

To allow pump operation to be tailored to your application, both the pressure and flow rate units may be set by the user, refer to Section 3.4.1.

The pump also allows user programmed refill, as well as pumping rates, refer to Section 3.4.3.

The system protection limits may also be set by the user, refer to Section 3.8.7.

3.2.2 Programming Screens

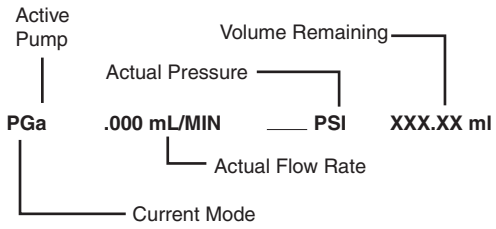
The programming screens are divided into separate menus. These menus are accessed when different features are being programmed. For complete information about programming menus, refer to Sections 3.3 through 3.7.

3.2.3 Run Screens

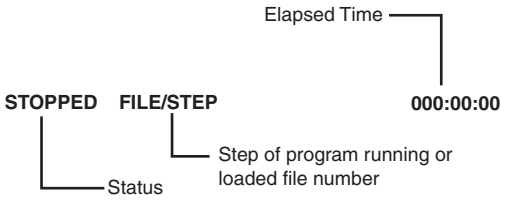
The run screen appears once a program has been loaded and the pump is running.

The run screen, which is determined by your program selections, displays current information about pump operation. The following sections explain the display line by line.

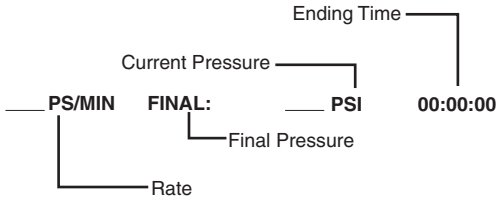
Line One – No matter what mode you are in, the first line of the run screen is always the same.



Line Two – The second line varies slightly depending on the operating mode. A file or step will only be displayed when operating in the gradient mode.



Line Three – Line three varies depending on the mode; the rate and units are set by the user, so these will vary depending on your programming requirements. The ending time will always be displayed on this line.



Line Four – Line four varies depending on the mode. The options presented on this line are softkey selectable, *i.e.* you use the softkeys (A - D) located under the screen to choose the option.

3.2.4 Selecting Operating Parameters

There are four ways to program the system from a menu screen.

Menu Selection – The number keys are used to select from listed menu items.

Softkey Selection – The softkey programming options appear on the fourth line of the screen. To either toggle or select an option, press the softkey, A-D, directly below that option.

Keypad Selection – The programming keys are located on the left side of the keypad. The pump mode, limits, and refill are all options that may be selected from the keypad.

Value Selection – The number keys are used to enter all numeric values required for pump operation. When a numeric value is required, a message will blink, prompting you to enter an appropriate value.

3.3 Main Menus

There are four main menu screens. Access Menu 1 by pressing MENU. To move forward and back between Menus 1, 2, 3 and 4, or to return to the run screen, use softkeys A (MORE) and D (PREVIOUS/RETURN).

Use the number keys to select a menu option. Selecting a menu option displays the programming parameters for that option in menu form.

> ***Note***
>
> To exit a menu when multiple pumps are connected, press the STORE, RECALL, CLEAR ENTRY OR MENU key.

3.4 Menu One

Menu 1 provides programming options for units of measure, pump selection, refill settings, power failure response, system reset, and display contrast adjustment.

To save all settings and return to the main menu, press RETURN (D).

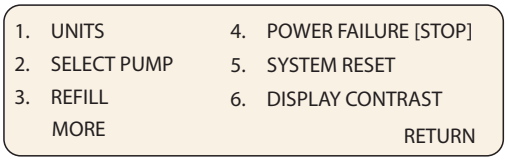


Figure 3-1 Menu 1 program selections

3.4.1 Flow and/or Pressure Units of Measure

Displayed units are user-selectable by selecting menu 1 item 1.

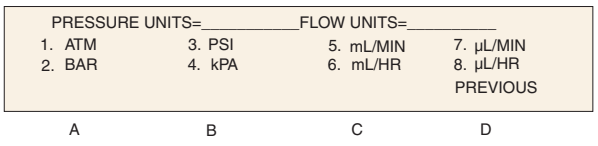


Figure 3-2 Units menu

Use numbers 1-4 to select the pressure units (ATM, BAR, PSI, kPa). The units selected will be displayed on the first line after PRESSURE UNITS=.

Use numbers 5-8 (mL/MIN, mL/HR, µL/MIN, µL/HR) to set the flow rate units. The selected units will be displayed on the first line after FLOW UNITS=.

3.4.2 Pump Selection (if multiple pumps)

If multiple pumps are connected to a single controller, the SELECT PUMP option selects the pump (A, B, C, or D) whose current state and settings appear on the display.

The letter of the current pump will appear in lower-case in the upper left corner of the run screen.

> ☑ ***Note***
>
> When multiple pumps are connected, the UNITS selected for one pump will apply to all of the pumps.

3.4.3 Refill

The refill option allows you to set the refill rate or set the pump to automatically refill when a certain volume is reached.

Press MENU > REFILL (3). The auto refill menu will appear.

> ☑ ***Note***
>
> If more than one pump is connected to the controller, pump B, pump C, and pump D will be displayed on the fourth line. To select a pump, press the softkey under the pump designation.

To set auto refill volume

Press 1 to set the volume for pump A.

The units to the right of the symbol will blink, indicating that you should enter a volume. Use the number keys to enter an appropriate value and then press ENTER.

To set refill rate

1. Press 3 to set the refill rate for the designated pump. The refill rate can also be changed from the main screen while the pump is refilling.
2. A message will blink on the screen prompting you to enter the selected refill rate.
3. Enter the desired rate with the number keys; press ENTER.
4. To save and exit the refill menu, press D, PREVIOUS.

Disable / Enable auto refill

The first line will display “OFF” or “ON”, indicating whether or not this feature is enabled for pump A (or the currently selected pump). Press 4 to toggle this feature off or on for each pump.

> ☑ ***Note***
>
> Auto refill can be set independently for each pump.

If AUTO REFILL is ON, the pump will automatically switch to refill mode when the volume reaches the auto refill mark. After refilling, pumping will resume in the programmed mode. The ACCESSORY outputs, which drive powered valves, will switch in sequence.

Unless otherwise specified, the pump will refill to full cylinder capacity. To specify a smaller refill volume, press 2 and enter the desired volume. Press 5 to toggle this feature off or on for each pump.

☑ Note

The system can also be programmed to refill a pump based on an external analog input voltage, with a range of 0 to 11.5 volts. Information about this feature is provided in Section 3.12.3.

3.4.4 Power Failure [STOP]

This feature allows you to set the activity of the pump in the event of a power failure. Press 4 to toggle this feature between [STOP] (to remain stopped after power is restored) or [CONT] (to automatically resume after power is restored).

☑ Note

In a multiple-pump system, this action is applied to all connected pumps.

3.4.5 System Reset (Restore Default Settings)

To restore default program settings, press 5. To continue with the reset, press CONTINUE (A); to cancel the reset, press DO_NOT (D).

⚠ CAUTION

Resetting the system erases all programs and user settings.

This is a basic reset. For information about performing a "hard" reset, refer to Section 9.4.2.

3.4.6 Display Contrast

From the menu, you can adjust the screen brightness for your light conditions and viewing angle.

Use softkeys B, DOWN, or C, UP to reduce or increase the brightness.

3.5 Menu Two

Menu 2 provides programming options for serial communication, pump status, external control, multiple pump operation, volume reset, and valve control.

To save all settings and return to the main menu, press PREVIOUS/RETURN (D).

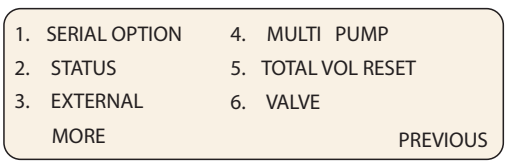


Figure 3-3 Menu 2 program selections

3.5.1 Serial Option

The serial option menu allows you to set the baud rate and the unit identification number.

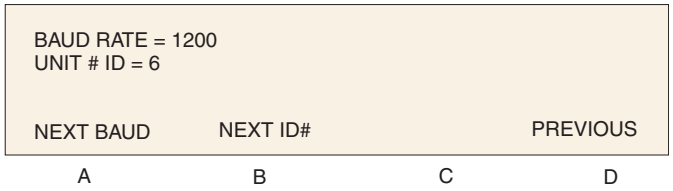


Figure 3-4 Serial option menu

Use softkey A, NEXT BAUD, to scroll through the available baud rates. These are: 300, 1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K, and 115.2K.

Use softkey B, NEXT ID#, to scroll through the available ID numbers. These are 1-7. Six is the default, as this is the unit identifier for the Teledyne Isco LabView™ software.

For a complete discussion of serial control, refer to Section 8 in this manual.

3.5.2 Pump Status

This option displays the controller software revision, and model of connected pump(s).

The first line displays the revision of the software.

Lines 2, 3, and 4 display the type of pump connected to the A, B, C, and D pump connectors, respectively.

This screen is also momentarily displayed automatically each time the pump controller is switched on.

3.5.3 External Control

The pump pressure or flow rate operation can be controlled externally with an analog voltage. Complete instructions for this feature are provided in Sections 3.12 through 3.12.5.

3.5.4 Multiple Pumps

One controller can control up to four pumps at once, either together or independent of each other.

Complete information about using the MULTI PUMP feature is provided in Section 3.9 and Section 5.6.

3.5.5 Total Volume Reset

This option resets the total volume display of multi-pump pair AB or multi-pump pair CD to zero when operating in continuous flow or modifier mode.

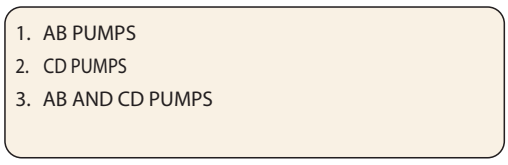


Figure 3-5 Total volume reset

3.5.6 Valve

This feature identifies the type of valves (passive, active (air), active ball (air), or electric) being used for the flow operation. Valves are set to "active" by default. If "active valve," "active ball valve," or "electric" is selected, the controller will match the pressure more closely before switching delivery pumps.

If "active ball" valve is selected, the controller will have a timed delay after valve open/closure before switching delivery pumps. This delay is to accommodate the slower opening/closing ball valves.

The number for the selected valve type will be blinking.

Press 1, 2, 3, or 4 to select the correct valve type.

> ☑ ***Note***
>
> The 30D pump has manual valve kits part number #60-1247-180 and #60-1247-181.

Electric Vale

Air Valve

Check Valve

Ball Valve

Figure 3-6 Types of valves

3.6 Menu Three

Menu 3 provides programming options for poor fills, diagnostics, pressure calibration, alternative pressure inputs, pressure control setting, and pressure setpoint tolerance.

To save all settings and return to the main menu, press PREVIOUS/RETURN (D).

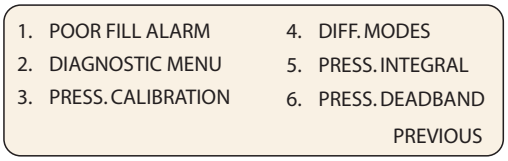


Figure 3-7 Menu 3 program selections

3.6.1 Poor Fill Alarm

In constant pressure mode, this feature allows you to set a fill point as a percentage of pump volume. If this volume percentage is not reached after a refill and re-pressurization, the system issues an alarm and stops the pump.

3.6.2 Diagnostic Menu

This selection displays an additional menu containing testing options for the system. Refer to Section 9.5 for a complete explanation of how to use the diagnostic menu.

3.6.3 Pressure Calibration

This is a stored psi value to ensure optimal operation of the pressure transducer. On most pumps, this value, known as the "midpoint adjustment," can be found on a tag on the transducer cable (shown below).

> ☑ ***Note***
>
> The midpoint adjustment value is individual to each pump, and is stored within the controller software. Therefore, this value must be re-entered if the controller or pump is switched, controller is reset, or if a pump is plugged into a different port on the controller.This calibration feature is not applicable to the HPx or 30D pump models.

Standard calibration for the transducer is a two-point adjustment, at zero and maximum pressure. The midpoint adjustment number is the difference between the pressure at half maximum, as read by a pressure gauge with a precision of 0.25% accuracy, and the syringe pump transducer output.

Figure 3-8 Location of transducer midpoint value

Press CALA, CALB, CALC, or CALD to select the correct pump, enter the calibration number, and press ENTER.

3.6.4 Diff. Modes

This feature allows the use of other analog inputs for pressure input to the pump. The standard pressure transducer **MUST** be connected to pump in order for this feature to work.

Press 1, OFF, to turn off this feature.
Press 2, 0 to 50 ANLG1, to use a 5 volt 50 psi transducer on ANALOG INPUT 1 of the ACCESSORY connector.
Press 3, Custom ANLG1, to use 5 volt custom pressure transducer on ANALOG INPUT 1 of the ACCESSORY connector.
Press 4, 500 ANLG2, to use a 5 volt 500 psi pressure transducer on ANALOG INPUT 2 of the ACCESSORY connector.
Press 5, 5000 ANLG3, to use a 5 volt 5000 psi transducer on ANALOG INPUT 3 of the ACCESSORY connector.

3.6.5 Press. Integral

The pressure control algorithm can be adjusted by turning OFF the integral compensation. This may be desirable at very low flow rates or during static tests. Under these conditions pressure control may be more stable with integral compensation off. If the pressure integral compensation is off, there will be a pressure error proportional to the delivery flow rate. For this reason, the pressure integral is normally turned on for anything but very low flow rates.

This feature is ON by default. Press 1, 2, 3, or 4 for the associated pump A, B, C or D to toggle the feature OFF.

3.6.6 Pressure Deadband

This feature prevents pump pressure "hunting" when delivering at low flow rates (<0.12 ml/min for the 30D pump or < 0.25 ml/min for other models). When this function is ON, the pump pressure may exceed the set point by up to 3 psi without the piston backing up to reduce the pressure. If the pump pressure exceeds the set point by more than 3 psi, the motor will reverse the piston until the 3 psi dead band maximum is reached. No dead band is allowed if the flow rate is above 0.25 ml/min (0.12ml/min for 30D pump) or when the pressure error is negative (pressure below the set point).

If the 3 psi positive pressure error is not acceptable at low flow rate, toggle the dead band feature OFF by pressing 1, 2, 3, or 4 for the associated pump A, B, C or D. This feature is ON by default.

3.7 Menu Four

3.7.1 Modbus Options

Beginning with Rev. 1.05 firmware, the Modbus RTU communications protocol is supported. Rev. 2.0 or higher firmware supports Modbus TCP communications protocol. Complete information about using Modbus RTU and Modbus TCP communication is provided in Section 7 *Modbus Configuration*.

3.8 Front Panel Keys

In addition to the menu options, certain functions and modes are selectable from the front panel keyboard.

3.8.1 CONST PRESS and CONST FLOW

These keys place the system in constant pressure mode or constant flow mode, respectively. Information for these operating modes can be found in Section 3.10.

3.8.2 PRGM GRAD

This key is used to place the pump system in gradient mode. For complete information about gradient programming, refer to Section 4 *Gradient Pumping for Pressure, Flow, and Concentration Modes*.

3.8.3 HOLD

The HOLD key is used while a gradient is running. When HOLD is pressed, the program clock freezes and current gradient parameters are maintained.

To continue the gradient, press HOLD or RUN.

3.8.4 RECALL

The RECALL key can only be used when the pump(s) are stopped or when in HOLD mode. The RECALL key is used to recall a previously programmed gradient. When you select this option, the controller automatically loads the gradient and switches the pump to program gradient mode.

1. Press RECALL and use the number keys to enter the number name of the gradient you wish to recall. Press ENTER.
2. If you enter a number of a gradient that does not exist, the controller briefly displays the message “FILE NUMBER DOES NOT EXIST.” It then assumes you will be creating a new gradient under that number and displays the program gradient run screen.

3.8.5 STORE

The STORE key is operational in the programmed gradient mode. It is used to save the program gradient parameters and exit the programming (parameter entry) mode.

3.8.6 REFILL

The REFILL key manually places the pump in refill mode.

3.8.7 LIMITS

The controller allows the user to set the minimum and maximum flow rate limits, the minimum and maximum pressure limits, and the maximum rate the pump will run while controlling the pressure in constant pressure mode.

- When using a single controller to operate multiple pumps, you need to select the appropriate pump before setting any pump parameters. The available pumps will be displayed above the softkeys. These selections correspond with the connector that the pump control cable is plugged into on the rear panel of the pump controller. To select a pump, press the softkey under the pump designation. The top line of the screen will indicate the currently selected pump.
- The maximum and minium limits you set cannot exceed the pump specifications.

To set the limits

1. Press LIMITS. To display the Limits menu, enter the number of the limit you wish to program. One of five limit setpoint menus will appear: MAX PRESS, MIN PRESS, MAX FLOW, MIN FLOW, or FLOW LIMIT. The MAX PRESS limit setpoint menu is shown in Figure 3-10.

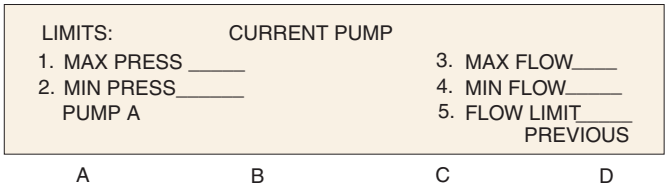


Figure 3-9 Limits menu

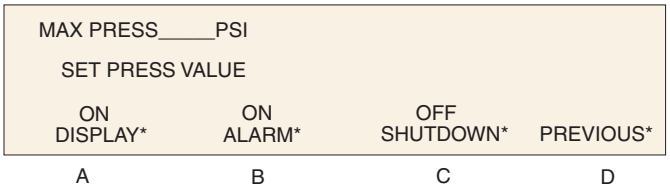


Figure 3-10 Limits setpoint (Max Press) menu

Note

These features are discussed later in this section under Limits Programming Options.

2. Press the number 1 key to set the value. A message will blink on the right side of the screen, prompting you to enter the selected limit.
3. Enter the desired limit setpoint, using the number keys.
4. Press ENTER to save the value.

Note

The pump can be set to shut off or not at this limit condition by pressing softkey C under shutdown. This will toggle this option to ON.

5. To exit the limit menu, press the softkey D, PREVIOUS. If four pumps are connected press STORE, RECALL, or CLEAR ENTRY to exit the limits menu.
6. Once all the limits have been set, press softkey D, PREVIOUS, to return to the main menu.

Limits programming options

In addition to setting the upper and lower limits, the pump also allows the user to specify whether they want:

- the alarm message displayed
- an alarm to sound when the limit is reached
- the pump to shut down when the limit is reached

These features are set using the softkeys A - C, which toggle the feature on and off.

> **Note**
>
> The Max Press (maximum pressure) display on and alarm on options cannot be disabled.

Display

When a limit has been exceeded, this feature causes the display to automatically flash an OVER or UNDER LIMIT message. To turn off this function, press softkey A once to toggle to:

OFF
DISPLAY

Alarm

When a limit has been exceeded, this feature causes the pump to automatically beep a warning. To turn off this function, press softkey B once to toggle to:

OFF
ALARM

Shutdown

When a limit has been exceeded, this feature causes the pump to shut down. To turn off this function, press softkey C once to toggle to:

ON
SHUTDOWN

Flow rate limit for pressure control

When the pump is controlling pressure (CONSTANT PRESSURE MODE), the flow rate is not user-controlled, and may range up to the maximum flow of the pump. In some cases, it is desired to limit the rate of pumping during system pressurization. This can be done by selecting limit 5, FLOW LIMIT. The FLOW LIMIT value is used as the upper range of flow rate during pressure control. This limit is not the same as the MAX FLOW limit, which is a threshold above when the pump is stopped, or an alarm is activated as selected by the operator.

To save your changes and return to the main menu, press softkey D, PREVIOUS.

3.8.8 RAPID PRESS

This option is available when operating in the constant flow mode and in the two-pump concentration gradient mode. It allows rapid pressurization to a stable pressure point and then switches automatically to the constant flow setpoint. This is helpful when you are operating at a low flow rate but wish to rapidly pressurize a solvent.

1. Press CONST FLOW to put the pump in constant flow mode, or enter a two-pump concentration gradient.
2. Press RAPID PRESS.

3. The controller will display maximum flow rate and target pressure setting. If these values are correct, press D to continue rapid pressurization.
4. If you know approximately what the pressure will be when the system is stable, enter this value as a target pressure. Press A and enter the desired pressure value. This should shorten the time required to stabilize the system pressure.
5. If you would like to limit the maximum flow rate during the rapid pressurization phase, press B and enter the desired flow rate limit.
6. Press D to continue rapid pressurization.

3.8.9 DISP

The DISP key activates Dispense Mode, for applications such as reactant feed and batch delivery, where a specified volume is pumped. Refer to Section 3.10.3 for programming steps.

3.8.10 ACC CTRL

The ACC CONTROL key will allow you to manually operate accessories, such as valves, via the Digital Output terminals on the back of the controller.

1. Press ACC CTRL.
2. From the accessory control menu, use the number keys 1-8 (1-A INLET, 2-A OUTLET, 3-B INLET, 4-B OUTLET, 5-C INLET, 6-C OUTLET, 7- D INLET, 8- D OUTLET) to toggle the desired valve open or closed. (Numbers 1-8 represent digital output terminals 1-8, respectively).
3. To exit, press PREVIOUS (D).

3.8.11 ZERO PRESS

The ZERO PRESSURE key will correct pressure sensor drift. Before pressing ZERO PRESS, the pump should have port fittings installed, and be depressurized.

1. Press ZERO PRESS. The display will show the current pressure and ask if you want to zero the pressure.
2. Press A, B, C, or D to zero the desired pump.

   or,

   If the pump is not depressurized, press DO_NOT (D) to exit the zero pressure operation. If four pumps are connected press the STORE, RECALL OR CLEAR ENTRY key.

3.9 Control of Multiple Pumps

When using multiple pumps, there are four multi-pump operating modes of delivery and one independent mode:

- Continuous flow in constant flow mode.
- Continuous flow in constant pressure mode.
- Modifier addition in constant pressure mode.
- Modifier addition in continuous flow, constant pressure mode.
- Independent mode.

☑ Note

The 30D pump cannot be used in multiple pump modes. Please contact the factory for details.

3.9.1 Multi-Pump Operation

A D Series continuous flow pumping system in constant flow mode will consist of two syringe pumps and a valve package, all regulated by one controller. Installation and operating instructions for this system are provided in **Section 5**.

A pump modifier system includes two D Series syringe pumps, regulated by one controller and outlet check valves to prevent system back flow into the pump. To connect the system, you will need a modifier addition kit. Consult with the factory when configuring 65D pumps as a modifier system.Installation and operating instructions for this system are provided in **Section 6**.

In these modes, the softkeys toggle between the options described in Table 3-1.

Table 3-1 Key functions in the Multi-pump Mode

Key	Display Option	Description
A	NORMAL	Uses a finer (slower) pressure match control when switching from one pump to the other.
	FAST	Uses a coarser (faster) pressure match control when switching from one pump to the other.
B	NORMAL PRESS	Uses pressure matching when switching from one pump to the other
	LOW PRESS	Uses no pressure matching when switching from one pump to the other.
C	DELIVER	Sets the pump into the delivery mode of operation.
	RECEIVE	Sets the pump into the receive mode of operation.
6	MIN/MAX POINTS	Sets the fill and refill marks that are used with both continuous flow modes. Sets the NCV feature On/Off. See Section 5.6.4.

3.9.2 Independent Control of up to Four Separate Pumps

A D Series syringe pump controller can run four syringe pumps independently of each other in either constant pressure, constant flow mode, dispense mode, or any combination of the three. To set up this option, use the following procedure.

1. Press MENU.

2. Press softkey A, MORE.
3. Press number 4, MULTI PUMP. The multi-pump menu will appear.
4. Press number 1 for pumps A or B, press number 2 for pumps C or D.
5. Press number 4, INDEPENDENT. The controller will set the pumps to Independent mode. Number 4 will blink, indicating that INDEPENDENT mode is selected.
6. Select the HOLD PRESS or NORMAL mode of operation. Press softkey A to toggle between the two modes.

   HOLD PRESS: In constant pressure mode, after the pump is empty, if the outlet pressure rises past the set point the pump will restart and run the system to the set point pressure.

   NORMAL: This feature shuts the system down if a pump runs empty in constant pressure mode.

   Once the pumps have been set to this mode, they will operate independently from one another. Each pump will operate at its defined limit and rate. Independent mode is the default setting for the pump.

   When you select a command such as STOP or REFILL, the display will prompt you to designate which pump to stop or refill. Only the designated pump will stop; the other pumps will continue to run.

> ☑ ***Note***
>
> In an emergency situation, toggling the On/Standby switch will cause all pumps to immediately stop.

7. Return to the run screen by pressing D three times. Then press D (SELECT PUMP). The display will show each pump's information and allow you to select any pump for programming changes.

3.10 Operating Modes

The pump has three delivery modes and one refill mode.

> ☑ ***Note***
>
> When using a single controller to operate multiple pumps independently, you need to select the appropriate pump run screen before selecting a mode. To select the appropriate pump, press SELECT PUMP (D) and an intermediate screen will be shown. Press the softkey for the appropriate pump, the run screen for that pump will appear.

Constant Flow – Refer to Section 3.10.1

This mode is used when the flow rate must remain constant during the pumping operation.

Constant Pressure – Refer to Section 3.10.2

The constant pressure mode is used when the application of fixed pressure throughout the pumping operation is required. The pump will maintain the desired pressure by positive or negative displacement of the piston.

Programmed Gradient – Refer to Section 4

In the programmed gradient mode, the pump can provide the following types of gradient:

- Two-pump concentration gradient on pumps A and B
- Single-pump linear pressure gradients on pump A
- Single-pump flow programs on pump A

Dispense – For applications requiring delivery of a specific volume. Refer to Section 3.10.3.

Refill – Refer to Section 3.4.3.

You can set the refill rate and change it when in refill mode.

3.10.1 Constant Flow

To set constant flow operation, use the following procedure:

1. Press CONST FLOW. “CFa” will be displayed in the upper left corner of the screen. This denotes that you will be defining constant flow parameters for pump A. If you wish to define parameters for pump B, C, or D, press softkey D, select pump, and then press softkey A, B, C, or D to select pump A, B, C, or D respectively.

☑ Note

If the main menu is displayed, you must press D under CONST FLOW.

2. Press A to change the flow rate. The words ENTER FLOW RATE will flash on the screen.
3. Use the number keys to enter the desired flow rate.

☑ Note

If you make an error, press CLEAR ENTRY to delete one character at a time.

4. Press ENTER once the desired flow rate is displayed.
5. Press RUN to begin pump operation.

3.10.2 Constant Pressure

Programming a constant pressure operation only requires a few keystrokes. Use the following procedure:

1. Press CONST PRESS; CPa will be displayed in the upper left corner of the screen. This denotes that you will be defining constant pressure parameters for pump A. If you

wish to define parameters for pump B, C, or D press softkey D, select pump, and then press softkey A, B, C, or D to select pump A, B, C, or D respectively.

☑ Note

If the main menu is displayed, you must press softkey D under RETURN before pressing CONST PRESS.

2. Press the A softkey to indicate to the program that you wish to enter the pressure. The words "ENTER PRESSURE" will flash on the screen.
3. Use the number keys to enter the desired pressure.

☑ Note

If you make an error, press CLEAR ENTRY to delete one character at a time.

4. Press ENTER once the desired pressure is displayed.
5. Press RUN to initiate pump operation.

3.10.3 Dispense Mode

For applications such as reactant feed and batch delivery where a specified volume is pumped, Dispense Mode is available with Teledyne Isco syringe pumps.

Dispense mode flow rate begins at zero, ramps up to level out at the programmed flow rate, then ramps back down to zero, delivering a precise specified volume. The slope rate and run time are dependent upon the pump model being used.

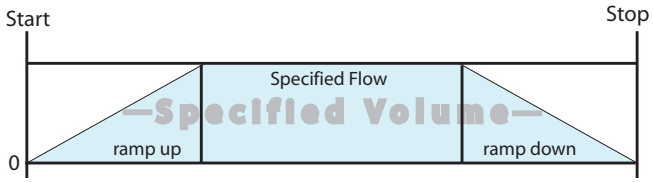


Figure 3-11 Depiction of dispense mode sequence

☑ Note

For time-controlled delivery, you must run the pump in standard gradient mode, as described in Section 4.

In order to access Dispense Mode control, the pump must be in Constant Flow mode. Press CONST FLOW to enter this mode. Toggle Dispense Mode off or on by pressing DISP. Note that pressing the DISP key while in Constant Pressure mode has no effect.

To adjust the flow rate, press FLOWRATE (A), enter the desired rate using the number keys, and press ENTER.

To specify the volume of the batch delivered, press VOLUME (C), enter the desired volume using the number keys, and press ENTER.

To dispense the batch, press RUN. The sequence runs once, then stops. To repeat the sequence, press RUN again.

> ☑ **Note**
>
> When the system is in Dispense Mode, all gradient modes, constant pressure mode, and auto-refill, as well as serial control, are unavailable until Dispense Mode is turned off.

3.11 External Control

The pump can be externally controlled for pressure or flow rate operation with an analog voltage or through the serial interface.

The serial interface allows you to control the pump operation from an IBM-PC or compatible computer that has an RS-232-C serial output. The serial interface accepts English command words from the computer, like constant pressure, refill, etc. For more information see Section 8 *Serial Interface*.

3.12 External Control: Analog

The syringe pump can be controlled externally by analog voltage in either constant flow or constant pressure mode. The input range is 0 – 11.5 volts (for all pumps), with a resolution of 5000 increments per volt.

> ☑ **Note**
>
> The input range for the 4-20ma option is set to 4-20ma

3.12.1 Wire connections

Two wires are required for analog control. The analog common or ground wire should be connected to the GND terminal under ANALOG INPUT of the ACCESSORY connector on the controller rear panel. The analog control or input wire should be connected to terminal 1 under ANALOG INPUT.

If two pumps are used with the controller, the second analog control or input wire should be connected to terminal 2 under ANALOG INPUT. If three pumps are used with the controller, the third analog control or input wire should be connected to terminal 3 under ANALOG INPUT.

If four pumps are used with the controller, the fourth analog control or input wire should be connected to terminal 4 under ANALOG INPUT.

When using one of the multi-pump operation modes, only the ANALOG INPUT terminal 1 needs to be connected to control the A-B pump pair and ANALOG INPUT terminal 3 needs to be connected to control the C-D pair.

> ☑ **Note**
>
> For the 4-20ma input option the negative output wire connects to DIGITAL GROUND. The positive output wire connects to ANALOG INPUT 1-4.

3.12.2 Preparation

Before programming the controller to accept the analog signal, you must know the maximum flow rate (constant flow) or the maximum pressure (constant pressure).

☑ Note

The high and low limits you enter cannot exceed the pump specifications: Normal input = 10V.

☑ Note

For the 4-20ma input option the negative output wire connects to DIGITAL GROUND. The positive output wire connects to ANALOG INPUT 1-4.

To determine the analog voltage range, use the formula explained below:

$$FS \times \left(\frac{V}{U}\right) = Vmax$$

where:

FS = Maximum flow rate or Maximum pressure
(Full Scale): This is the same value entered when setting LIMITS, as described in Section 3 of your user manual, for MAX PRESS or MAX FLOW.

V = Volts per unit of flow or pressure

U = Incremental unit of flow or pressure

Vmax = Maximum input voltage

☑ Note

For the 4-20ma input option The maximum flow or pressure sets the limit at 20ma. No other formula applies.

3.12.3 External Control for Refill

The refill option allows you to set the refill rate, or set the pump to automatically refill when a certain volume is reached. From Menu 2, the system can be programmed to automatically refill a pump based on an external analog signal, with a range of 0 to 11.5 volts.

To access this feature, press MENU > MORE (A) > EXTERNAL (3).

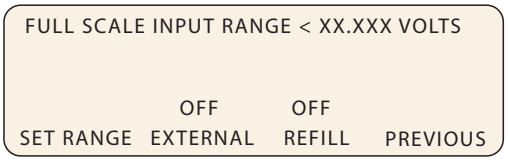


Figure 3-12 External control for refill menu

To set the full-scale value (maximum 11.5 volts), press SET RANGE (A), enter the desired value, and press ENTER.

To place the pump under external control, press EXTERNAL (B). The feature will turn from OFF to ON.

To SET the external control for refill, press REFILL (C). The feature will turn from OFF to ON.

3.12.4 Calculation Examples

Flow Rate – If MAX FLOW is set at 25 ml/min in the LIMITS menu and the desired scale factor is 5.0 volts per 20 ml/min, do the following to determine the analog voltage range:

$$25 \times \left(\frac{5}{20}\right) = 6.25$$

In this example, the analog voltage range would be 0.0–6.25 volts.

Pressure – If MAX PRESS is set at 510.2 ATM in the LIMITS menu and the desired scale factor is 2.0 volts per 100 ATM, do the following to determine the analog voltage range:

$$510.2 \times \left(\frac{2}{100}\right) = 10.204$$

In this example, the analog voltage range would be 0.0–10.204 volts.

> ☑ ***Note***
>
> If the controller is equipped with 4-20ma input then the low signal is 4ma (stop) and high signal is 20ma (run).

3.12.5 Setup

First, select the desired operating mode by pressing CONST PRESS or CONST FLOW.

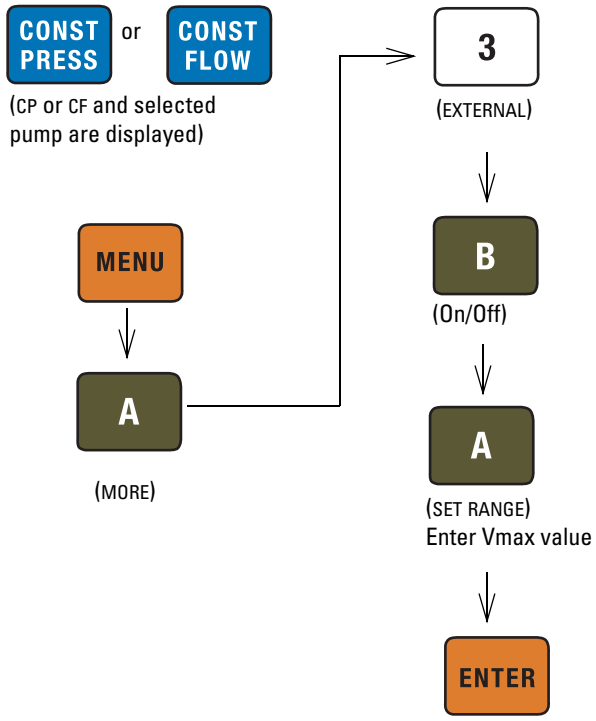


Figure 3-13 Button sequence for external control setup

3.13 Remote RUN/STOP

The D series syringe pump RUN/STOP function can be externally controlled by a switch contact closure or TTL input. The input voltage is 5 volts and is internally pulled high (RUN). The input is level sensitive (must remain high for RUN or low for STOP) and must be high for normal operation of serial (RS-232) control.

To enable the remote RUN/STOP feature, press MENU > MORE> (A) > EXTERNAL > (3) > DIGITAL (A) ON. Then press RUN or force the RUN/STOP pin low to enable the pump. Thereafter, the RUN/STOP pin will control operation.

first press RUN or force the RUN/STOP pin low to enable the pump. Thereafter, the RUN/STOP pin will control operation. Pressing STOP on the front panel will override the RUN/STOP pin.

3.13.1 Wire Connections

Two wires are required for external RUN/STOP control. The digital common or ground wire should be connected to one of the four DIGITAL GROUND terminals of the ACCESSORY connector on the controller rear panel. The control wire should be connected to terminal 1, under DIGITAL INPUT. If an electrically isolated relay is used, one relay terminal should be connected to digital ground and the other to terminal 1, under DIGITAL INPUT.

If two pumps are used with the controller, the second control wire should be connected to terminal 2, under DIGITAL INPUT.

If three pumps are used with the controller, the third control wire should be connected to terminal 3, under DIGITAL INPUT.

If four pumps are used with the controller, the fourth control wire should be connected to terminal 4, under DIGITAL INPUT.

☑ Note

For the 4-20ma option, the negative current wire is connected to DIGITAL GROUND and the positive should be connected to DIGITAL INPUT

3.14 Analog Flow Rate and Volume Output Options

The analog output option provides for analog monitoring of the syringe pump flow rate. If two or less pump modules are connected to the controller, pump volume delivered can also be monitored via analog output. These outputs are often used with analog based plant or process monitoring equipment.

3.14.1 Voltage Analog Output

Output voltage for pressure is located on the back panel of the pump module via standard banana jacks.

The output connection is the female 25-pin Sub-D connector located on the rear panel of the controller, under 4-20mA Output.

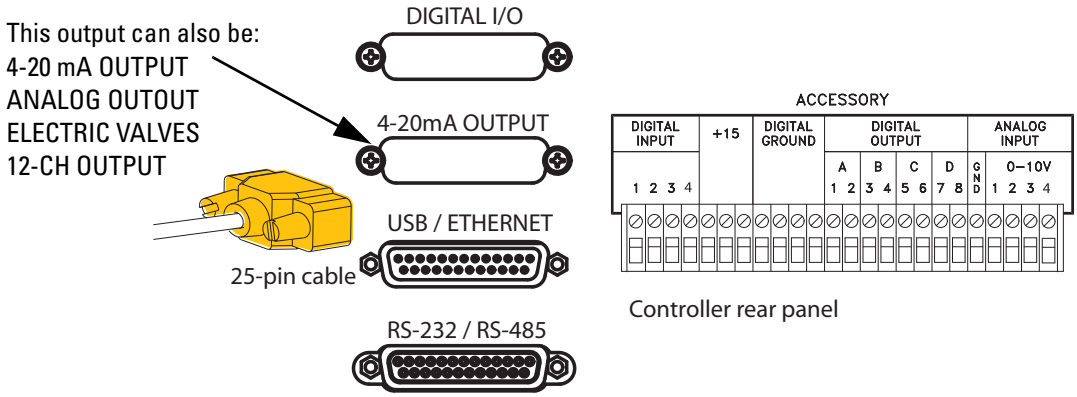


Figure 3-14 Analog voltage output connection, rear panel

Voltage analog outputs are pre-installed at the factory. This option has a total of four outputs for monitoring flow rate with selectable ranges from 0 to 5V, -5 to +5V, and 0 to 10V. The default range at installation is 0 to 10V. Each output can be set to a different range.

The top of the selected range is the same maximum value entered for MAX FLOW when setting LIMITS, as described in Section 3.8.7 of this manual. For example: if the output range is

5V and the preferred output scale is 1 volt per 10 ml/min, MAX FLOW is set at 50 ml/min. MAX FLOW cannot exceed the pump specification.

A controller running one to two pumps can also output cylinder volume on the remaining outputs. The volume output range is not adjustable. Full scale is equal to one pump stroke.

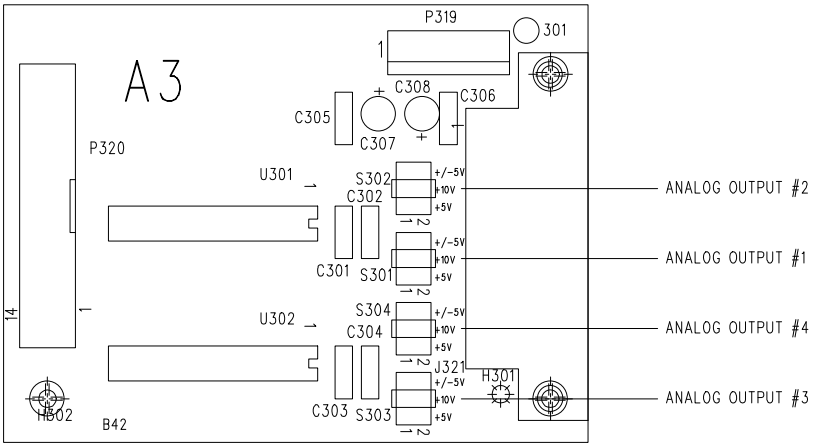


Figure 3-15 Output range selection jumpers

Table 3-2 Analog Output Options (connections to female 25 pin Sub-D)

Pin No.	Description	One or Two Pump Function	Three Pump Function
1	Chassis (earth)	—	—
2	Analog common	—	—
3	Analog common	—	—
4	Analog common	—	—
5	Analog common	—	—
14	Output #1	Flow Rate A	Flow Rate A
15	Output #2	Flow Rate B	Flow Rate B
16	Output #3	Volume A	Flow Rate C
17	Output #4	Volume B	Volume B

For additional information about analog output options, download technical bulletin TB34Syringe Pump Analog Output Options.

3.14.2 Current Loop Output

The pump controller can be configured to provide a 4–20 mA current loop output. The 4-20mA analog output board is pre-installed at the factory, but can also be purchased in an upgrade kit. The board initially contains three output cards, for flow rate, pressure, and volume for Pump A. Additional cards can

be purchased to output data for one or two more pumps. Refer to Table 3-3 for connections for the 4-20mA and 0-10v 12 channel outputs.

☑ Note

Connections to the controller DB-25 are the same as shown in figure 3-14. Refer to Table 3-3 and Table 3-4 for cable connections to your equipment.

Table 3-3 Analog Output Signal/Sub-D Pins for 4-20mA

Pin #	Channel	Data Type/Pump
14	1	Pump A Flow Rate
1		Pump A Flow Rate (Signal Return)
15	2	Pump A Pressure
2		Pump A Pressure (Signal Return)
16	3	Pump A Volume Remaining
3		Pump A Volume Remaining (Signal Return)
17	4	Pump B Flow Rate
4		Pump B Flow Rate (Signal Return)
18	5	Pump B Pressure
5		Pump B Pressure (Signal Return)
19	6	Pump B Volume Remaining
6		Pump B Volume Remaining (Signal Return)
20	7	Pump C Flow Rate
7		Pump C Flow Rate (Signal Return)
21	8	Pump C Pressure
8		Pump C Pressure (Signal Return)
22	9	Pump C Volume Remaining
8		Pump C Volume Remaining (Signal Return)
23	10	Pump D Flow Rate
10		Pump D Flow Rate (Signal Return)
24	11	Pump D Pressure
11		Pump D Pressure (Signal Return)
25	12	Pump D Volume Remaining
12		Pump D Volume Remaining (Signal Return)

Table 3-4 Analog Output Signal/Sub-D Pins for 0-10 VDC

Pin #	Channel	Data Type/Pump
1	1	Pump A Flow Rate
14		Pump A Flow Rate (Signal Return)
2	2	Pump A Pressure
15		Pump A Pressure (Signal Return)
3	3	Pump A Volume Remaining
16		Pump A Volume Remaining (Signal Return)
4	4	Pump B Flow Rate
17		Pump B Flow Rate (Signal Return)
5	5	Pump B Pressure
18		Pump B Pressure (Signal Return)
6	6	Pump B Volume Remaining
19		Pump B Volume Remaining (Signal Return)
7	7	Pump C Flow Rate
20		Pump C Flow Rate (Signal Return)
8	8	Pump C Pressure
21		Pump C Pressure (Signal Return)
9	9	Pump C Volume Remaining
22		Pump C Volume Remaining (Signal Return)
10	10	Pump D Flow Rate
23		Pump D Flow Rate (Signal Return)
11	11	Pump D Pressure
24		Pump D Pressure (Signal Return)
12	12	Pump D Volume Remaining
25		Pump D Volume Remaining (Signal Return)

D Series Syringe Pumps

Section 4 Gradient Pumping for Pressure, Flow, and Concentration Modes

4.1 Introduction

Gradient pumping is used in applications requiring time-controlled or rate-controlled delivery of a specific volume at a set flow rate or pressure, or a two-pump flow concentration.

All Teledyne Isco syringe pump models can be used in gradient mode. The model 65D requires special hardware for this. Call the factory for complete information.

You can program the controller to increase or decrease pressure or flow during different steps within a single program by entering a specific value at the beginning and end of each step.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

Tools and Parts for Single Pump System

Open-end wrenches: 1/4", 5/16", 7/16", 3/8"

Manual Refill Valve Kit - see Table 4-1

Manual Outlet Valve Kit - see Table 4-2

Tools and Parts for Dual Pump System

Open-end wrenches: 1/4", 5/16", 7/16", 3/8"

Manual Refill Valve Kit -
see Table 4-1 (two kits required)

Gradient Mixer Package - part #68-1247-080

Table 4-1 Manual Refill Valve Kits

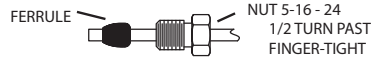
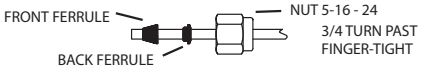
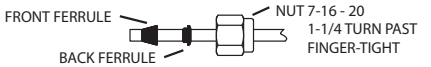
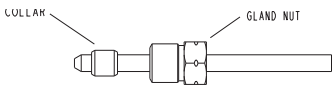
Pump Model	Part Number
1000D	68-1247-117
500D	68-1247-083
65DM, 100DM/DX, 260D	68-1247-077
65D	68-1247-127
30D	60-1247-180

Table 4-2 Manual Outlet Valve Kits	
Pump Model	**Part Number**
1000D	68-1247-118
500D	68-1247-082
65DM, 100DM/DX, 260D	68-1247-078
65D	68-1247-126
30D	60-1247-181

4.2 Connecting the System

The syringe pump has two ports at the top of the cylinder. One port is used as the inlet for filling the pump, and the other as the outlet (either port may be used as inlet or outlet). Inlet and outlet connections to each pump must be made identically. Standard plumbing connections vary between pump models. See Table 4-3 for standard port information.

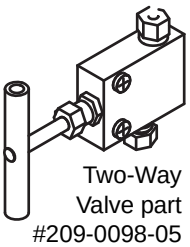
When making fluid connections that use ferrules, be sure to use the ferrules supplied for that pump by Teledyne Isco. Push the tubing completely into the connector and finger-tighten. Then tighten with a wrench to clamp the ferrules onto the tubing.

Table 4-3 Swaging Detail		
65DM, 100DM/DX, 260D	1/8" Valco	
500D	1/8" NPT	
1000D	1/4" NPT	
65D/30D	1/4" F250C	

☑ *Note*

Pump models 260D, 100DM/DX, and 65DM have a direct connection, as shown in Figures 4-1 and 4-2 on the following page. Valve kits for other models include male adapter fittings.

A gradient pumping system includes high-pressure, two-way valves that connect the pump inlets to fluid reservoirs, and the pump outlets to the gradient mixer (dual pump system) or other apparatus (single pump system). Each refill kit and outlet valve package contains one two-way valve; the gradient package contains two. The kits contain all tubing and hardware necessary for valve installation.



Two-Way Valve part #209-0098-05

Following installation, the tubing connections must be tested for leaks before any program is run. If a leak is found, tighten the connection slightly. If the leak persists, swage the connection again with a new ferrule. Refer to Technical Bulletin TB05 Field Verification Procedures at http://www.isco.com/sp_applications/#techbulletins for leak test procedures.

4.2.1 Inlet Connections

Kit components and connections are shown in Figure 4-1.

1. Mount the inlet valve on the pump housing with the spacer block and screws provided.
2. Connect the pre-bent SST tubing from one port of the valve to the pump inlet. Use the nut and ferrule to connect the tubing at the inlet and the valve fittings to connect the tubing at the valve.
3. Connect the PTFE refill tubing (with the filter) to the other port of the valve, using the nuts and ferrules supplied.

> ☑ ***Note***
>
> When connecting to pressurized sources in supercritical fluid applications, use the stainless steel tubing **without** a filter. An in-line filter is contained in the CO_2 connection package (refer to technical bulletin TB08 CO_2 Applications and Technical Notes at http://www.isco.com/sp_applications/#techbulletins).

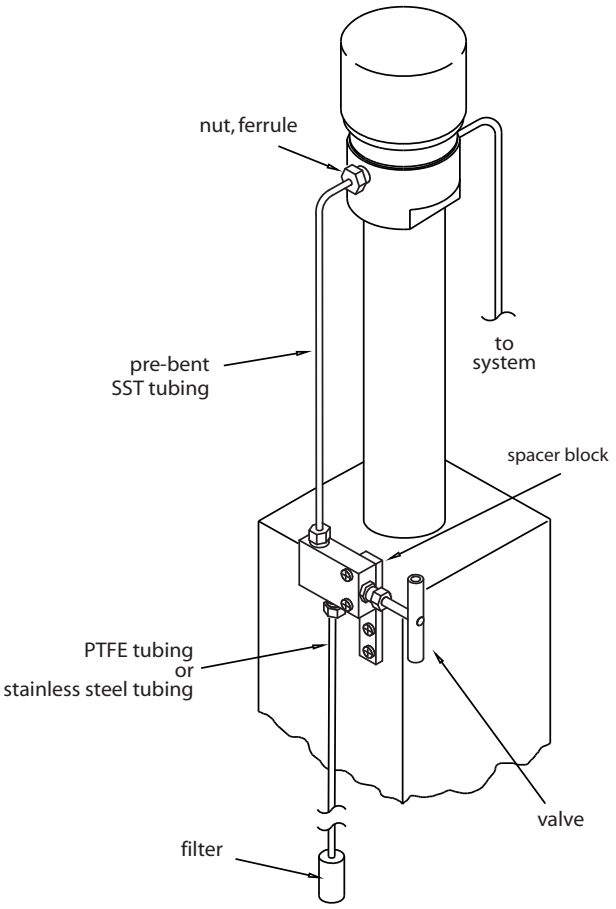


Figure 4-1 Pump inlet connections

4.2.2 Outlet Connections

Kit components and connections are shown in Figure 4-2.

1. Mount the two-way outlet valve on the side of the pump housing opposite the refill valve, with the spacer block and screws provided.
2. Connect the pre-bent SST tubing between one port of the valve and the pump outlet. Use the nut and ferrule to connect the tubing at the outlet and the valve fittings to connect the tubing at the valve.
3. Connect the 5.1 cm length of 1/8" tubing to the other port of the valve, using the valve fittings.
4. Connect the 1/8" side of the reducing union to the tubing.
5. Connect the 1/16" side of the reducing union to the 1.5 m length of 1/16" tubing. (This tubing may be cut to an appropriate length.)

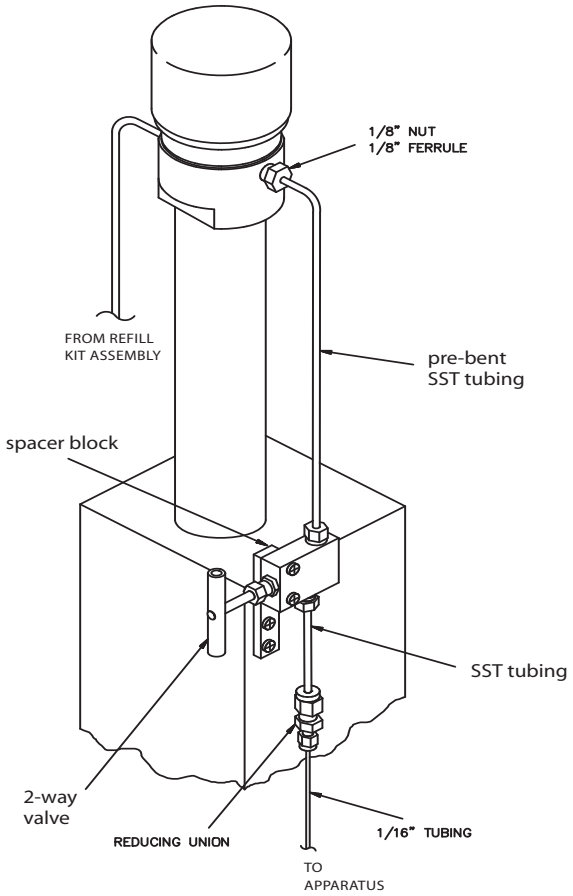


Figure 4-2 Pump outlet connections

4.2.3 Dual Gradient System Connections

Connection of the dual gradient system requires two refill valve kits and the gradient mixer package, as discussed in the introduction on Page 4-1.

> **☑ Note**
>
> The Dual Gradient System is not available for the 30D pump. Please contact the factory for details.

The static mixer has an internal volume of 3.1 µl and pressure rating of 413.7 bar, and is supplied with PEEK Fingertight III fittings for connection to the 1⁄16" tubing in the kit.

> **☑ Note**
>
> The static mixer can be replaced by a user-supplied dynamic mixer.

Solvents are fed from each pump through the in-line filters and check valves, and into the static mixer, where they are mixed and fed into your system apparatus.

Kit components and connections are shown in Figures 4-3 and 4-4.

1. Connect the 10 cm length of 1⁄16" stainless steel tubing to the center port (outlet) of the mixer using the PEEK fittings provided.
2. Connect the other end of the tubing to the Valco valve at the port marked “P” (pump), using a Valco 1⁄16" nut and ferrule.
3. Connect the two in-line filters, oriented with flow toward the check valves (indicated by the arrow on the housing), one filter to each piece of 1⁄16" stainless steel tubing outlet from each pump.
4. Using the PEEK fittings, connect the 45.7 cm lengths of 1⁄16" stainless steel tubing to each inlet port on the mixer. Connect the other ends to the outlet fittings of the check valve assemblies.
5. Connect the two check valve inlets to the outlets of the in-line filters with the 12.7 cm lengths of tubing.
6. Press the check valves into the clips on the stand, as shown below, oriented with flow in the upward direction (indicated by the arrow on the housing).

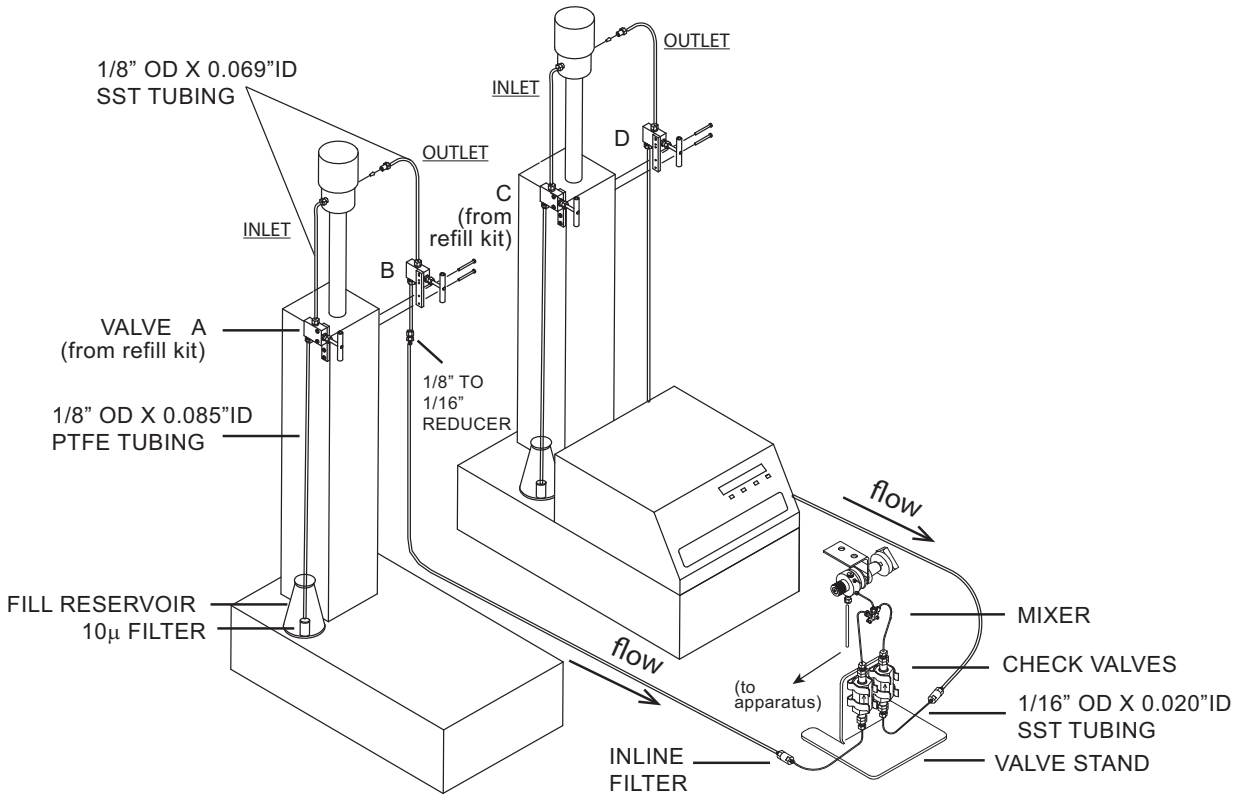


Figure 4-3 Dual gradient system connections
(Inlet valves (A & C) are from refill valve kits)

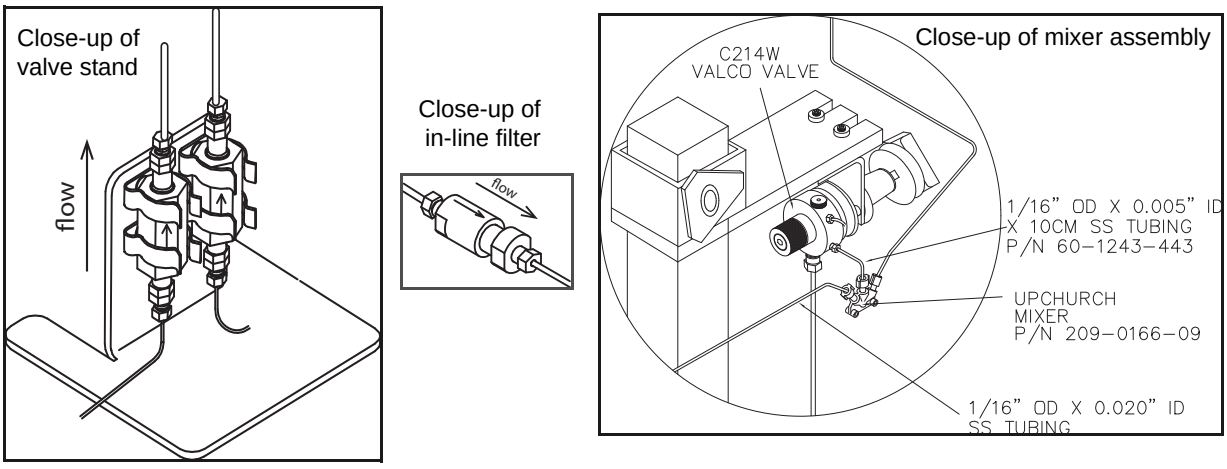


Figure 4-4 Dual gradient connections: Detail

4.3 Single-Pump Gradient Programming

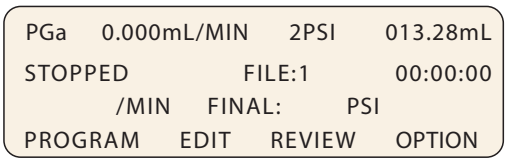
A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

The controller's memory can contain a total of up to 200 steps. One program can contain from 1 to 200 steps.

When operating in gradient mode, any connected pumps not used for gradient are inoperable.

1. To access the gradient programming menus, press PRGM GRAD, select PRESSURE (2) or FLOW (3), and CONTINUE (C).

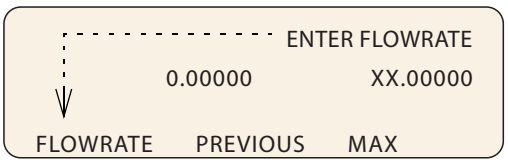
   The home screen will appear, with either PG (Pressure Gradient) or FG (Flow Gradient) in the upper left corner.



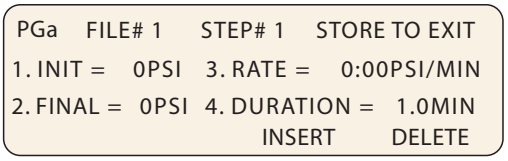
2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***Note***
>
> If a selected stored program is in a different mode than that of the controller selected in Step 1, a brief notification will appear, displaying the controller's mode and the file's mode. If you attempt to run the program without changing the mode of either it or the controller, the program will not run, and the same message will be displayed.

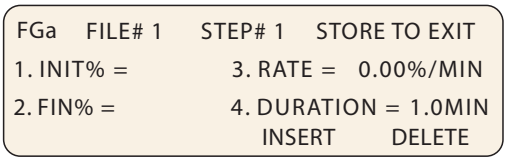
4. To enter the flow rate for this program, either press FLOWRATE (A) and use the number keys and Enter, or for maximum possible flow, simply press MAX (C).



5. To proceed to the programming screen, press STEP FWD (B).
   The programming screen will appear, with the file number and step number at the top of the screen.



or



6. To set the initial pressure or flow for this step, press INIT (1) to activate this parameter. Use the number keys to enter the desired value, then press ENTER to save it.
7. To set the final pressure or flow for this step, press FINAL (2) to activate this parameter. User the number keys to enter the desired value, then press ENTER to save it.
8. Set either the desired RATE (3) of change or DURATION (4) in minutes. Once one value has been set and saved, the other will automatically appear.

☑ Note

DURATION in minutes can have a resolution of 0.1, with a maximum of 9,999 minutes per step.

9. If you want to add another step to the file program, press INSERT (C).
10. The step number will increase by one, and the default initial value will be the final value entered for the previous step. Edit as desired.
11. When programming is complete, press the STORE key to save the file and return to the home screen.
12. To start the program, press RUN two times.

☑ Note

When a gradient run is started, digital output **8** of the controller ACCESSORY connector will toggle from high to low (open to closed) for one second.

Note that an entire gradient program can be removed only by deleting each of its steps one at a time, as discussed in Section 4.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

4.4 Dual Pump Concentration Gradient Programming

Two-pump concentration gradients enable proportionate use of two different fluids that combine at the mixer (refer to Figures 4-3 and 4-4).

This type of pumping uses flow mode (FG) only. A single-pump gradient program is based on either pressure or flow, and controlled by either time duration (in minutes) or rate of change (units per minute).

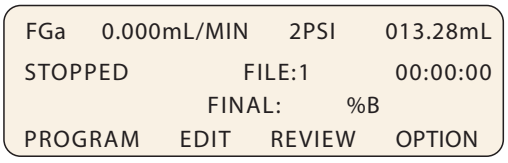
> ☑ ***Note***
>
> The Dual Pump Concentration Gradient is not available for the 30D pump. Please contact the factory for details.

The controller's memory can contain a total of up to 200 steps. One program can contain from 1 to 200 steps.

When operating in gradient mode, any connected pumps not used for gradient are inoperable.

1. To access the gradient programming menus, press PRGM GRAD, then DUAL SYSTEM GRADIENT (1) and CONTINUE (C).

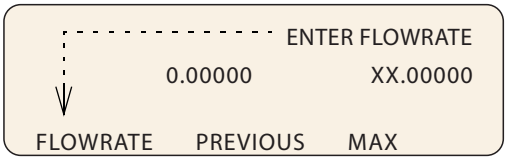
   The home screen will appear, with FG (Flow Gradient) in the upper left corner.



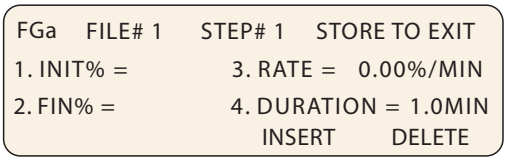
2. Press PROGRAM (A).
3. At the prompt, enter a file number between 1 and 99. This is the file name of your program, and can be the name of a new program you are creating, or a stored program you want to edit or run. Press ENTER.

> ☑ ***Note***
>
> If a selected stored program is in a different mode than that of the controller selected in Step 1, a brief notification will appear, displaying the controller's mode and the file's mode. If you attempt to run the program without changing the mode of either it or the controller, the program will not run, and the same message will be displayed.

4. To enter the flow rate for this program, either press FLOWRATE (A) and use the number keys and Enter, or for maximum possible flow, simply press MAX (C).



5. To proceed to the programming screen, press STEP FWD (B).
   The programming screen will appear, with the file number and step number at the top of the screen.



6. To set the initial pressure or flow for this step, press INIT (1) to activate this parameter. Use the number keys to enter the desired value, then press ENTER to save it.
7. To set the final pressure or flow for this step, press FINAL (2) to activate this parameter. User the number keys to enter the desired value, then press ENTER to save it.
8. Set either the desired RATE (3) of change or DURATION (4) in minutes. Once one value has been set and saved, the other will automatically appear.

☑ *Note*

DURATION in minutes can have a resolution of 0.1, with a maximum of 9,999 minutes per step.

9. If you want to add another step to the file program, press INSERT (C).
10. The step number will increase by one, and the default initial value will be the final value entered for the previous step. Edit as desired.
11. When programming is complete, press the STORE key to save the file and return to the home screen.
12. To start the program, press RUN two times.

☑ *Note*

When a gradient run is started, digital output **8** of the controller ACCESSORY connector will toggle from high to low (open to closed) for one second.

The flow rates and ramp rate for Pump A in each step will be in direct opposite proportion to the values set for Pump B (INIT%B, FIN%B, and RATE).

Note that an entire gradient program can be removed only by deleting each of its steps one at a time, as discussed in the next section, 4.5 *Review, Revise, & Hold Options*. When the last remaining step is deleted, the entire file is removed.

4.5 Review, Revise, & Hold Options

While in the programming menu, you can also:

Delete – To delete the current step, press DELETE (D). A deleted step cannot be recovered. Used repeatedly, this command can be used to delete an entire file.

Review – To review existing program steps, press STEP BACK (A) or STEP FWD (B).

Add New – To add a new step between two existing steps, navigate through the program to the step just before your addition. Press INSERT (C) and program the new step.

Note that the initial value of the next step will default to the final value of the new step, and may need to be edited if a different initial value is needed.

While Running – A gradient program can be reviewed or edited while it is running. Simply press EDIT (B) or REVIEW (C) to begin. If a new step duration is shorter than the elapsed time for that step, the program will proceed to the next step. If the total flow rate is changed, the program will immediately start using the new rate.

To return to the run screen, press RETURN (D).

Hold – You can hold a running gradient in its current state while retrieving a different program file to run in its place. Press Hold and then Recall to access the new program.

This feature is used mainly in applications where it is necessary to keep the system pressurized during method changes.

External Start – When a gradient program is in Hold mode, a momentary low on digital input **2** of the controller ACCESSORY connector will start the program.

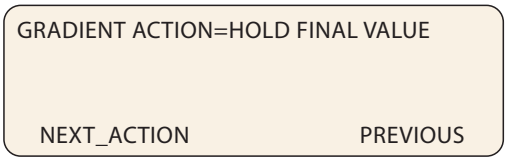
4.6 Program Conclusion

When a gradient program reaches the end, there are four selectable actions the system can then perform:

- Hold the final value *(example below)*
- Stop after the final step
- Return to the initial value and hold it
- Return to the initial value and repeat the program

While the system is in gradient mode, these options can be edited at any point before or after gradient programming, and while a gradient is running.

To access the options menu, from the home screen, press OPTIONS (D).



To scroll through the four options, press NEXT_ACTION (A). When you have reached the desired option, press PREVIOUS (D) to save and exit.

D Series Syringe Pumps

Section 5 Continuous Flow Introduction, Installation, & Operation

5.1 Introduction

A D Series continuous flow pumping system consists of two syringe pumps and a valve accessory package regulated by one controller. This system allows you to continuously deliver liquefied gas or liquid under constant flow or constant pressure mode.

Continuous flow can be used in either of two modes: continuous constant pressure or continuous constant flow. Both of these modes assume positive displacement of the piston, with the exception of continuous Receive Mode (for detailed information about Receive Mode, refer to technical bulletin TB02 Constant Pressure Pump Operation for Receive Mode, available on the Teledyne Isco web site).

In any syringe pump continuous flow system, a flow irregularity occurs at the time of switchover from one pump module to the other. This flow irregularity can be measured as a pressure fluctuation. Teledyne Isco pressure fluctuation at switchover is ~0.35 bar (at system backpressures from 6.9 bar to the single pump maximum).

Before programming continuous flow, appropriate valves must be connected, the pumps must contain fluid, and there must be backpressure for operation.

> ☑ ***Note***
>
> Continuous flow is not available with the 30D pump. Please contact the factory for details.

5.2 Continuous Flow Check Valves

The following section describes the installation procedure for continuous flow check valves.

> ☑ ***Note***
>
> Due to the higher operating pressure and special fittings, the model 65D pump requires hardware that is not listed in this section. Call the factory for details to configure a 65D pump for this type of operation.

The check valve package connects two D-Series syringe pumps, allowing continuous flow operation. The tees, check valves, and connecting tubing come assembled so that you can quickly and easily install this package in your system. For additional convenience, the two lengths of pump connection tubing come with the

fittings already attached. The only connections you have to make are between the pump tubing and the double check valve housings and between the outlet and inlet tubing and the tees.

5.2.1 Check Valve Technical Specifications

Dual system maximum flow rates under optimal conditions are approximately 65% of the max flow rate for each pump model.

Table 5-1 Continuous Flow Technical Specifications-Check Valves:

Pressure fluctuation at switchover	0.35 bar, at system backpressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system backpressure	The single pump maximum. Valves rated to 689.5 bar
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate.	C1000D 265.2 C500D 132.6 C260D 69.55 C100DX 32.50 C100DM 16.25 C65DM 19.50
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	0 to 40°C
Wetted materials in valve packages:	
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

5.2.2 Dual Check Valve Installation

Check valve installation refers to Figure 5-1 or 5-2, depending on your pump model.

☑ *Note*

Tighten fittings just enough to hold tubing in place. Final tightening will be done after all the tubing and fittings are in place.

1. Move the pumps so that the pump bases are about 1.3 cm apart.
2. Use the plugs to stopper the ports which will not be connected to the continuous flow package.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Attach the connectors appropriate to your pump to the 6.4 cm unbent stainless steel tubing lengths and use the

⅛" nuts and ferrules to attach to the double check valve housings.

4. Attach the inlet tubing assembly. The tubing you use depends upon whether or not your source is pressurized.
   a. Pressurized Reservoir:
   Connect the ⅛" × 1.5 m stainless steel tubing to the bottom of the inlet tee, using high pressure valve fittings.

☑ Note

The filter and PTFE tubing are not used.

   b. Nonpressurized Reservoir:
   Connect the ⅛" × 1.5 m PTFE tubing to the bottom of each inlet check valve using the ferrule and nut with support spring provided in the package. Attach the tubing to the filter connector and then connect the filter.

☑ Note

The stainless steel tubing is not used.

5. Once the contents of the continuous flow package are totally assembled, attach the connectors appropriate for your pump on one side of the assembly to a port. Then, supporting the tee/valve assembly attach the other connector to the port of the second pump.
6. Attach the outlet fittings to the top of the upper tee. Fittings for ⅛" tubing, as well as an optional reducing fitting for 1⁄16" tubing, are provided. Use the fittings appropriate for your tubing size.
7. Tighten all fittings.

5.2.3 Inlet Tubing

There are two types of inlet tubing provided with this kit. The stainless steel tubing is to be used for a pressurized inlet source, the PTFE tubing may be used if the source is not pressurized.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

☑ Note

The fittings for connection to pressurized source are not provided. A CO_2 cylinder connection package (P/N 68-1247-043) is available. Refer to section 2A.3.2 of the Instruction Manual.

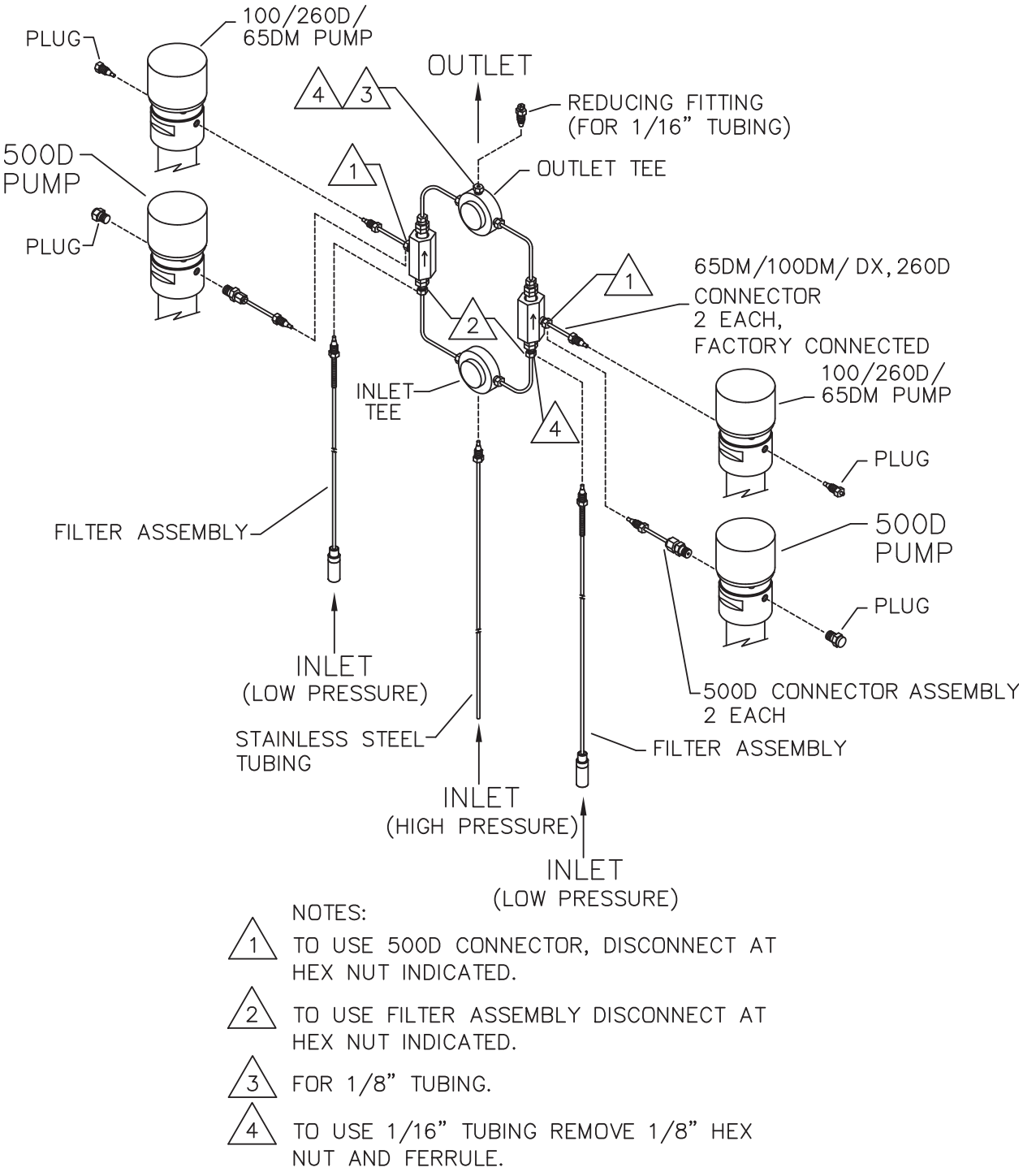


Figure 5-1 Check valve package installation: 65DM / 100D / 265D / 500D pumps

Table 5-2 Continuous Flow Check Valve Package for 100D/260D /500D, part #68-1247-059

Qty.	Part Number	Description
3 loose	209-0169-41	1/8" ferrule
3 loose	209-0169-27	1/8" nut
2	209-0168-05	1/8" pipe plug
2	209-0166-80	1/8" plug assembly
4	60-2253-240	Check valve housing, analytical standard inlet
4	60-3864-010	Check valve cartridge
4	60-1243-519	6.4 cm x 6.4cm tubing
2	60-1243-518	6.4 cm tubing
1	60-1243-391	1.5 m - 0.125" tubing
2	60-1243-557	1.5 m - 0.085 ID PTFE tubing
2	60-1243-517	Double check valve housing
2	209-0161-01	0.12" male connector
2	209-0161-36	Tee union for 1/8" OD tubing
1	209-0169-42	Reducing tubing connector 1/8" to 1/16"
1	60-2258-019	Nut assembly
1	209-0169-81	Male nut for 1/8" tubing
2	209-0169-80	10 µ replacement filter

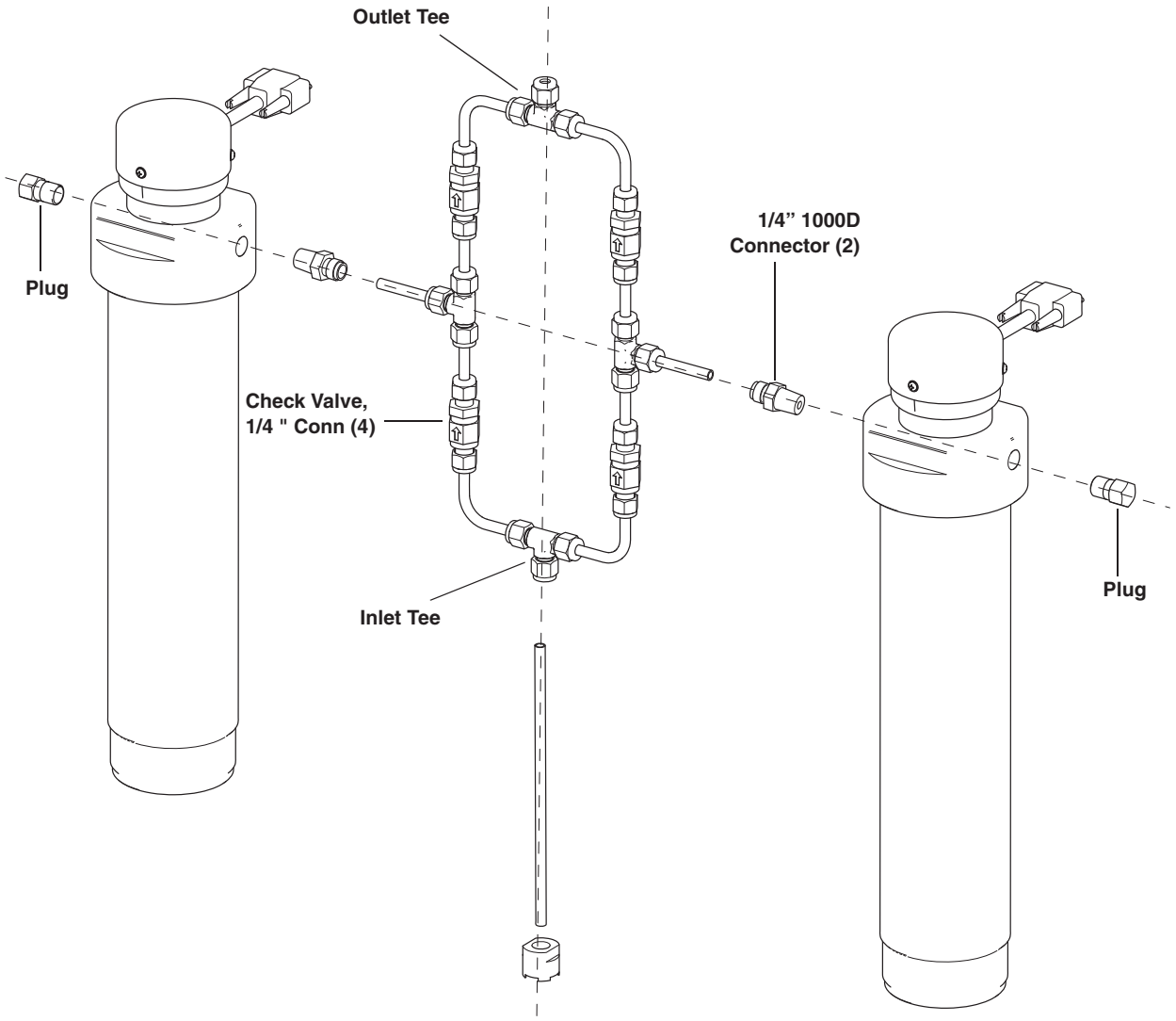


Figure 5-2 Check valve package installation: 1000D pump

Table 5-3 Continuous Flow Check Valve Package for 1000D, part #68-1247-128

Qty.	Part Number	Description
24"	004-7302-251	SST tubing .250 x .035
6	60-1243-893	Valve-to-pump tubing
2	209-0163-36	Male connector, 1/4" tube OD to 1/4" NPT
4	209-0164-06	Check Valve w/ 1/4" tube connections
4	209-0168-15	Tee union, 1/4" tube OD
4	60-1243-936	2" x 2" SST tubing elbow

5.3 Continuous Flow Air Valves

Air valves generally open and close faster and are less prone to error and component wear, making them suitable for industrial use and other applications where the system will be constantly running; however, they require a user-supplied pressurized air source of 80 to 115 psi (5.5 to 7.9 bar).

Air Valve Package Numbers

A1000D	68-1247-104
A500D	68-1247-061
A500HPx	60-5364-343
A65DM, A260D, A100DM, A100DX	68-1247-058
A65D	68-1247-129

Table 5-4 Continuous Flow Technical Specifications-Air Valves:

Pressure fluctuation at switchover	5 psi (0.35 bar), at system backpressures from 100 psi (6.9 bar) to the single pump maximum. Higher fluctuation occurs at pressures below 100 psi.
Minimum	50.76 psi (3.5 bar)
Maximum system backpressure	The single pump maximum. Valves rated to 10,000 psi (689.5 bar)
Air supply source pressure	80 to 115 psi (5.5 to 7.9 bar)
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate.	A1000D 265.2 A500HPx 265.2 A500D 132.6 A260D 69.55 A100DX 32.50 A100DM 16.25 A65DM 19.50 A65D 16.25
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	0 to 40°C
Wetted materials in valve packages:	
Air valves	Hastelloy, PEEK, and PTFE
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

5.3.1 Dual Air Valve Installation

To install the air valve package (refer to Figure 5-3, 5-5, or 5-6, depending on your pump model):

1. Position the valve bases 1.3 cm apart.
2. Use the plugs to stopper the ports which will not be connected.

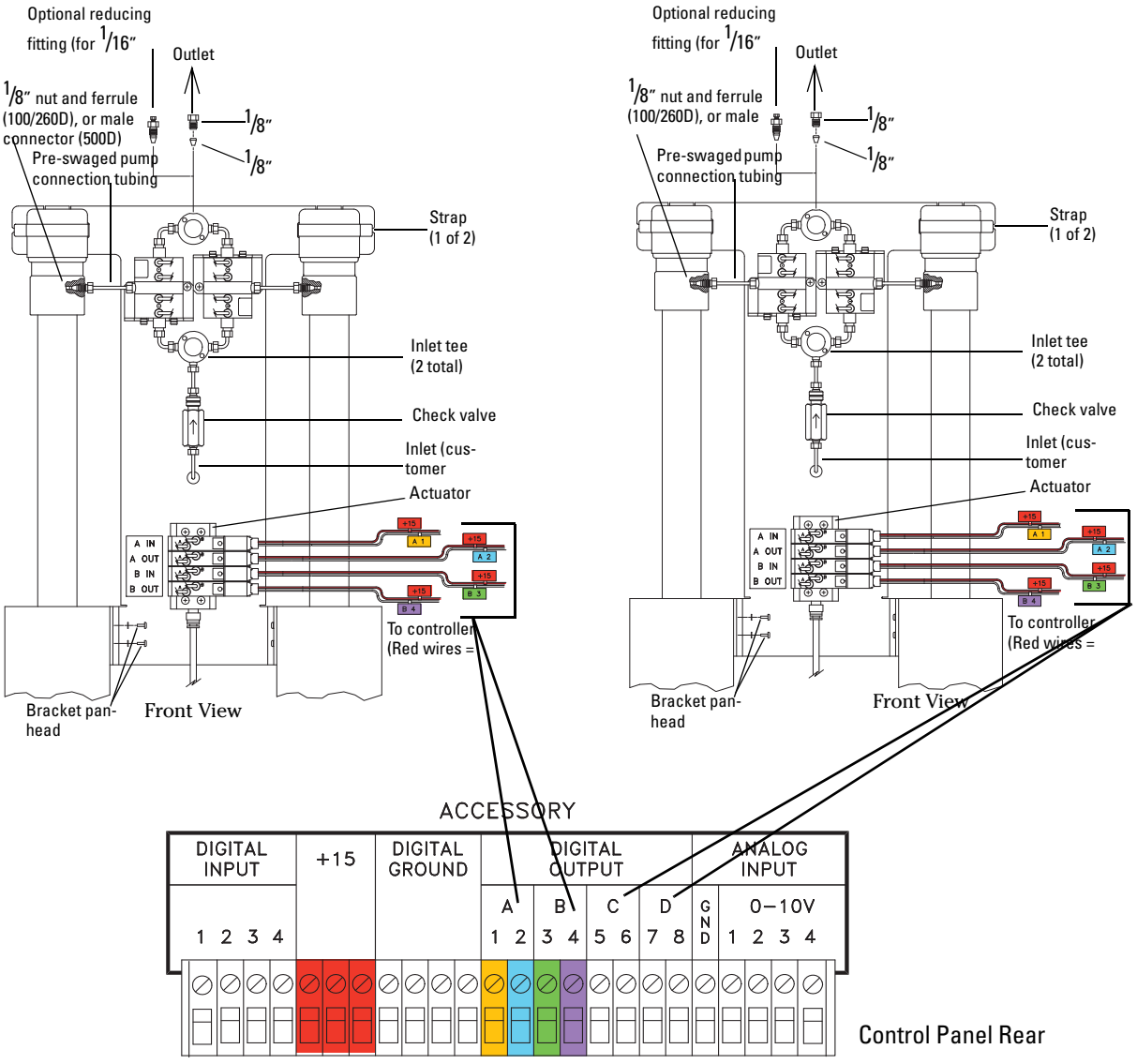
⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Loosely attach the tubing lengths from the valve assembly to the pumps.
4. Allow the bracket to hang vertically; place the straps around the pressure transducer caps. Tighten the wing-nuts.
5. Install the four panhead screws on bottom of the bracket.

Plumbing connections

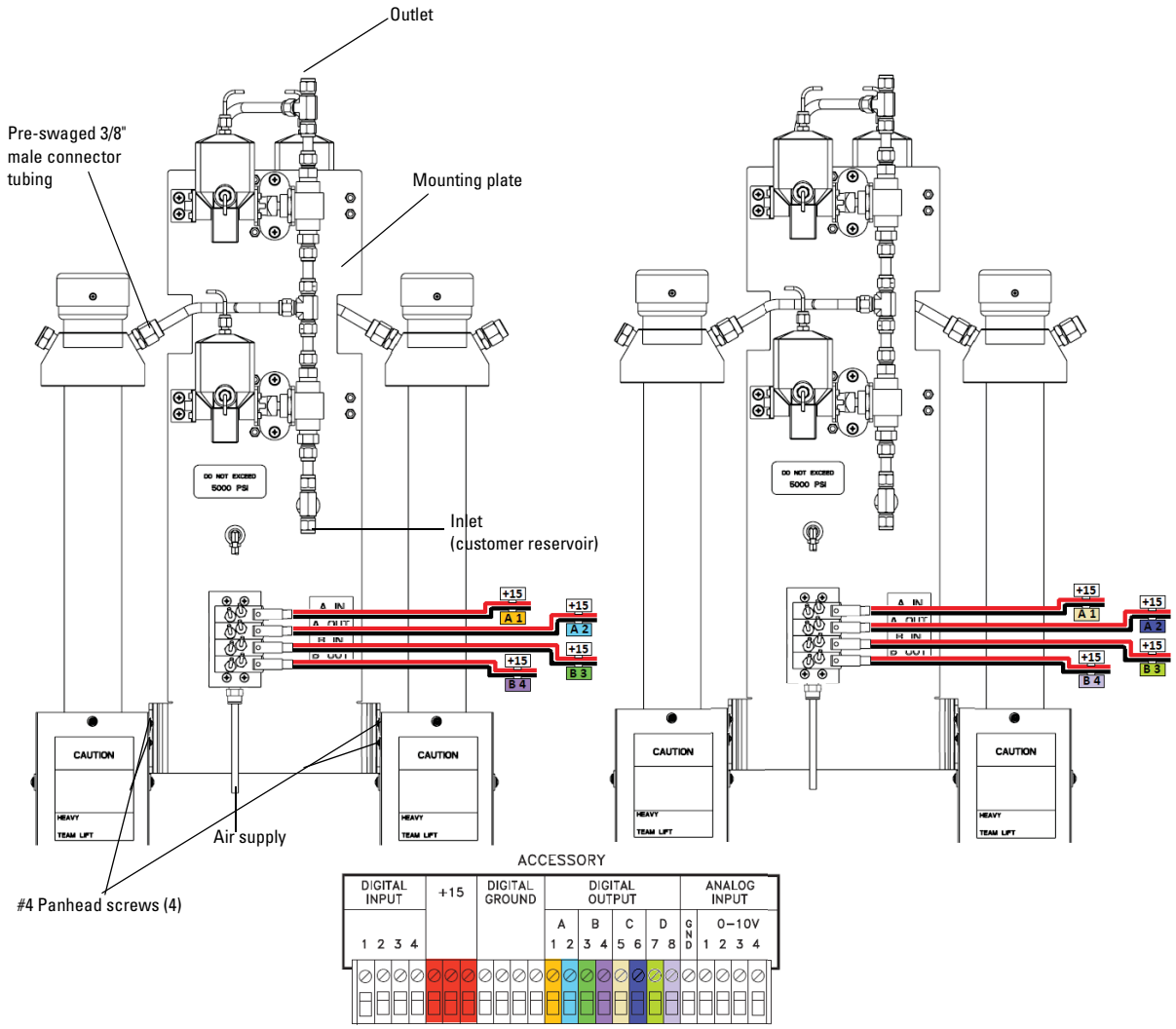
6. Tighten the tubing nuts.
7. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

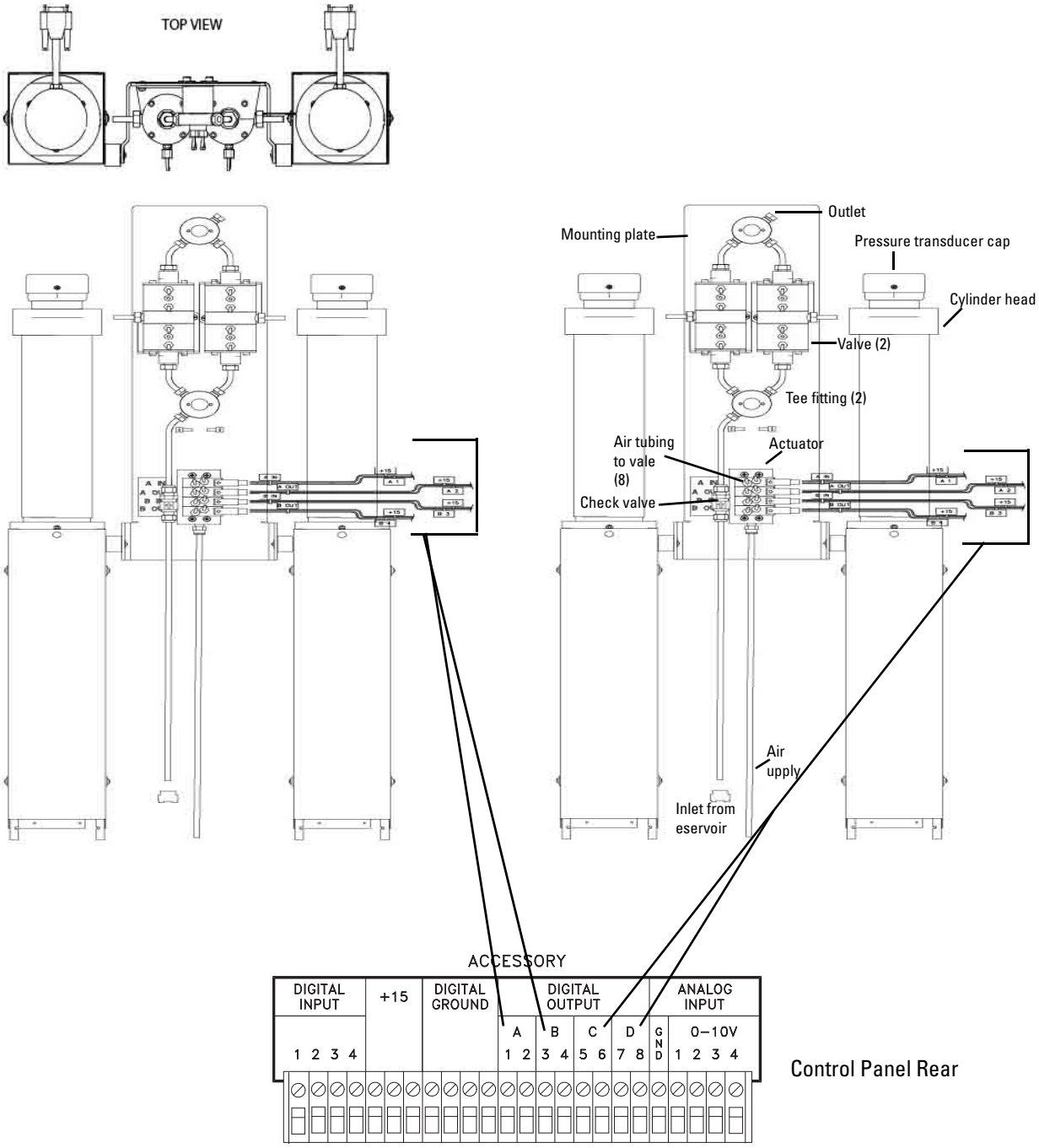
Figure 5-3 Air valve installation for 65DM, 100DM/DX, 260D, and 500D pumps



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

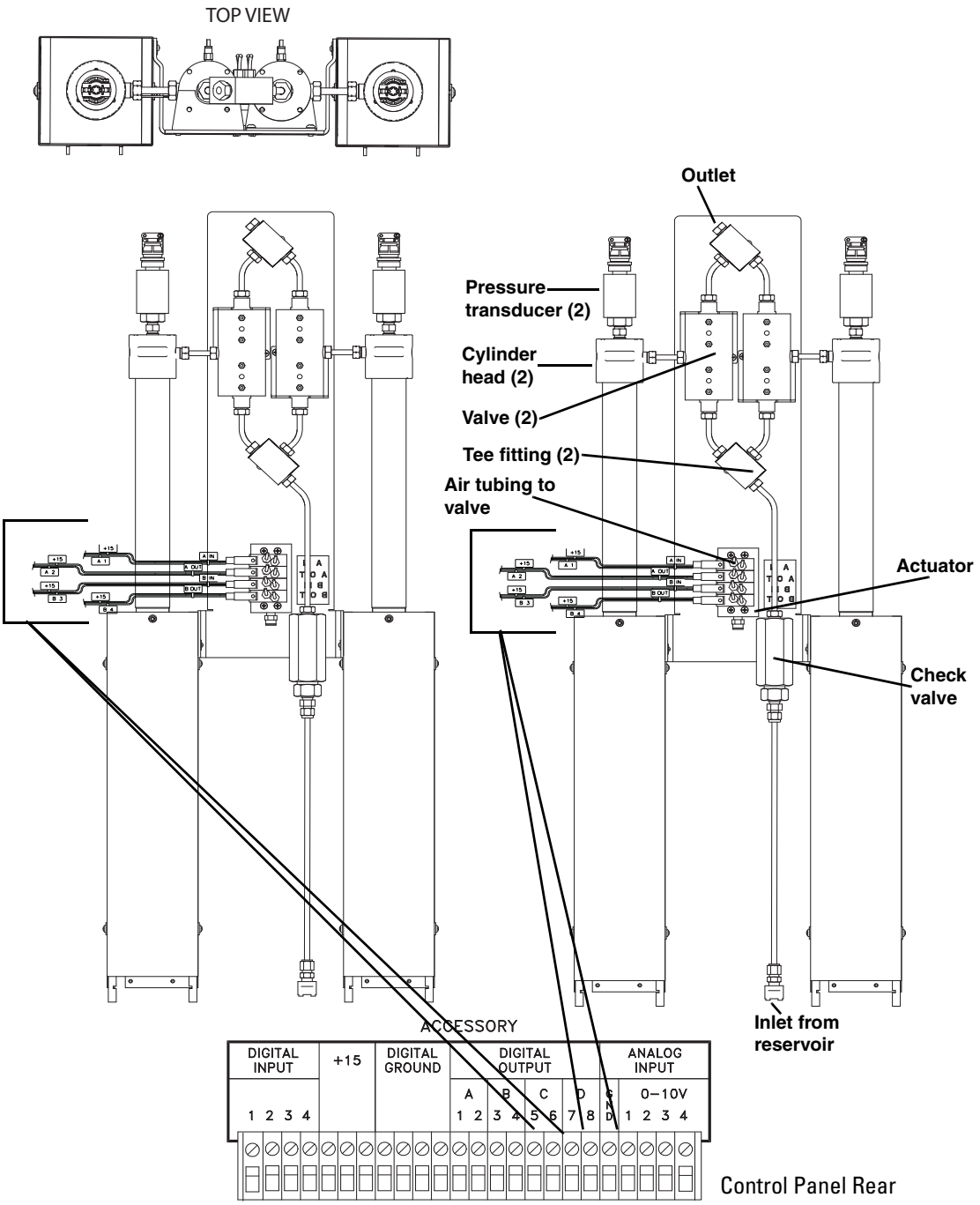
Figure 5-4 Air valve installation for 500HPx pumps



Wire pair con-

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

Figure 5-5 Air valve installation for 1000D pump



Wire pair conversion table for A-B Pump Pair and C-D Pump Pair

A-B Pump Wire Pair	Digital Output	+15 Wires		C-D Pump Wire Pair	Digital Output	+15 Wires
A1	A1	+15		A1	C5	+15
A2	A2	+15		A2	C6	+15
B3	B3	+15		B3	D7	+15
B4	B4	+15		B4	D8	+15

Figure 5-6 Air valve installation for 65D pump

5.4 Continuous Flow Electric Valves

Electric valves, which provide the best positive valve closure, are most commonly used in liquefied gas applications. Electric valves require the pump controller to be equipped with the valve driver board.

> ☑ ***Note***
>
> The max flow rate for the **E1000D** dual system will tend to have a lower percentage flow rate due to port size restrictions, with a maximum flow rate equal to that of the **E500D** system (see Table 5-5).

Electric Valve Package Numbers

E1000D	68-1247-109
E500D	68-1247-091
E65DM, E260D, E100DM, E100DX	68-1247-090

> ☑ ***Note***
>
> Electric valves are not available for the **65D and 500HPx** pumps. Please consult the factory for options.
>
> Electrical valves can only be used with pumps A, B.

5.4.1 Technical Specifications

Dual system maximum flow rates under optimal conditions are approximately 65% of the max flow rate for each pump model.

Table 5-5 Continuous Flow Technical Specifications-Electric Valves:

Pressure fluctuation at switchover	0.35 bar, at system backpressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system backpressure	The single pump maximum. Valves rated to 689.5 bar
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate (excluding E1000 systems).	E1000D 132.6 E500D 132.6 E260D 69.55 E100DX 32.50 E100DM 16.25 E65DM 19.50
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	0 to 40°C
Wetted materials in valve packages:	
Check valves	SS316, sapphire, ruby, PEEK, PTFE
Tubing and fittings	SS316, gold

5.4.2 Dual Electric Valve Installation

To install the electric valve package (refer to Figure 5-7 on the following page):

1. Position the valve bases 1.3 cm apart.
2. Use the plugs to stopper the ports that will not be connected.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 700 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Loosely attach the tubing lengths from the valve assembly to the pumps.
4. Allow the bracket to hang vertically and place the straps around the pressure transducer caps. Tighten the wing-nuts.
5. Install the four bracket panhead screws on the bottom of the bracket.

Plumbing connections

6. Tighten the tubing nuts.
7. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.

Electrical connections

8. Connect the DB-25 cable to the controller rear panel “SFX 220/VALVES” connector (Figure 5-7).

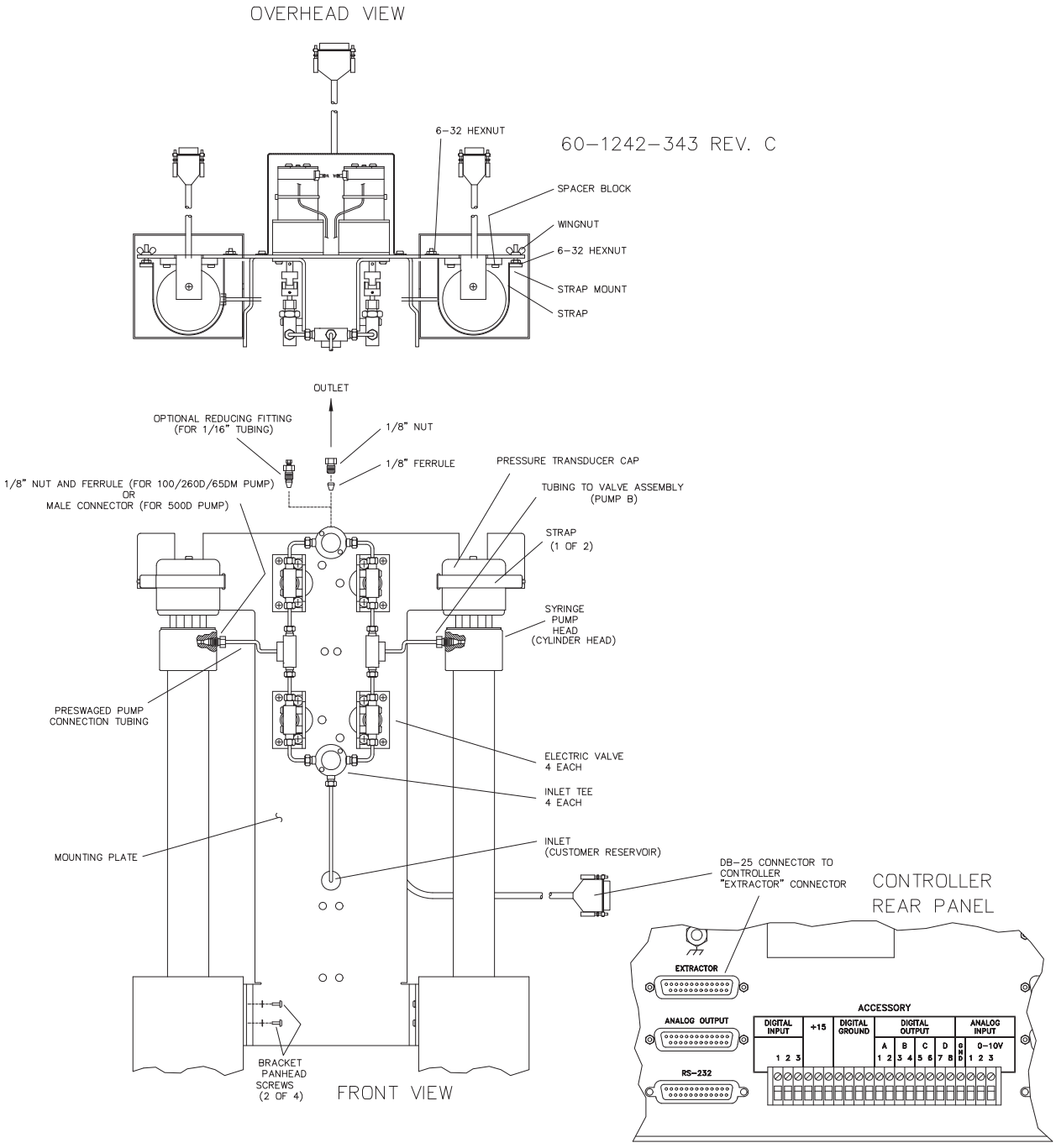


Figure 5-7 Electric valve installation

5.5 User Supplied Valves

Users may also choose to supply their own valves. The following information is necessary to choose the appropriate valves to work with Teledyne Isco Continuous Flow software.

- Check valves

  Do not use spring-loaded check valves if refilling at atmospheric pressure; the pump seals are not designed to draw against a vacuum. The balls in Teledyne Isco check valves are closed by gravity.

- Powered valves

  These are electrically triggered from the pump controller and could be air or electrically actuated. Digital outputs 1-4 provide signals for control of four two-way valves. One wire for each valve is connected to its specific connector on the rear of the controller. A second wire for each valve connects to ground. The signal provided is an open collector which functions as a switch open for closure of the fluid path. A switch closure (low) signals opening of the fluid path.

Table 5-6 shows the relationship between the digital output, pump valve location, and the fluid path status for the ACCESS CTRL connections. Refer to the accessory control connections on the rear panel of the pump controller.

Table 5-6 Accessory Control Digital Outputs

Digital Output	Pump Valve Location	Fluid Path Status
1	A	Inlet (open or closed)
2	A	Outlet (open or closed)
3	B	Inlet (open or closed)
4	B	Outlet (open or closed)
5	C	Inlet (open or closed)
6	C	Outlet (open or closed)
7	D	Inlet (open or closed)
8	D	Outlet (open or closed)

Alternate connections can be made to drive low power 12-15 V relays or electric valves. Assume two wires per relay or valve. The first wire is connected to the appropriate digital output on the back of the pump controller. The second wire can be connected to the +15 V connector, to supply a maximum of 200 mA for switching of relays or valves. Observe correct polarity if the valve or relay is polarized.

5.6 Continuous Flow Mode

Once your valve package has been properly installed and you have ensured that fluid connections are leak-free, the system is ready for operation.

> ☑ ***Note***
>
> Teledyne Isco convention is to name the pumps "pump A" and "pump B," reading from left to right.

Before running in continuous flow mode, become familiar with independent mode, which allows the controller to operate two pumps independently and simultaneously. You must operate the two pumps manually for initial setup, *i.e.* refill and purging of air. If the Teledyne Isco air valve package is used, the air valves are switched through ACCESS CTRL. When air valves are used, lights on the air valve actuator indicate which valves are open.

Table 5-7 Key functions in the Multi-pump Mode

Key	Display Option	Description
A	NORMAL	Uses a finer (slower) pressure match control when switching from one pump to the other.
	FAST	Uses a coarser (faster) pressure match control when switching from one pump to the other.
B	NORMAL PRESS	Uses pressure matching when switching from one pump to the other
	LOW PRESS	Uses no pressure matching when switching from one pump to the other.
C	DELIVER	Sets the pump into the delivery mode of operation.
	RECEIVE	Sets the pump into the receive mode of operation.
6	OTHER OPTIONS	Sets the fill and refill marks that are used with both continuous flow modes. Sets the NCV feature On/Off. See Section 5.6.4.

5.6.1 Defining Operation

Select Pump – This menu allows you to select any pump to display its run screen (program and operation data) and to make program changes.

Valve specification – To prevent pressure fluctuation at switchover, you must specify the type of valve package you are using.

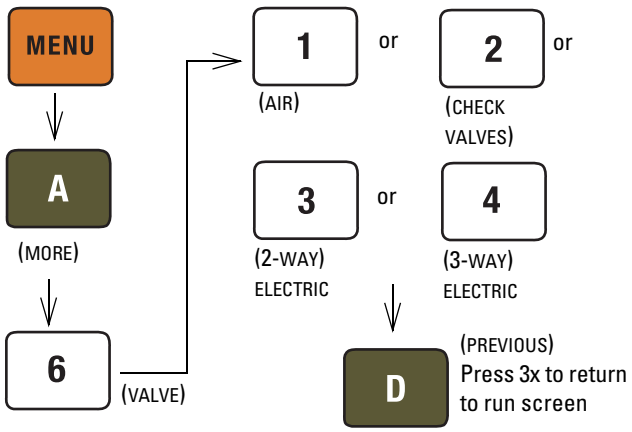


Figure 5-8 Keystrokes to specify valve type

Note

In older controller versions, only buttons 1 (ACTIVE) and 2 (PASSIVE) are selectable when specifying the valve type being used (Figure 5-8). *Active* refers to air or electric valves; *Passive* refers to check valves.

Volume totalizer – The total volume delivered is displayed in liters at the top right corner of the screen. Refer to the figure below to reset the volume totalizer to zero.

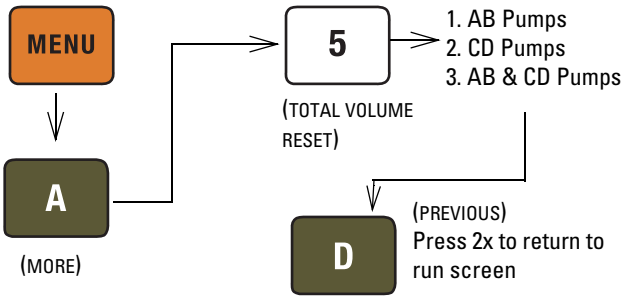


Figure 5-9 Keystrokes to reset volume totalizer

5.6.2 Constant Flow Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

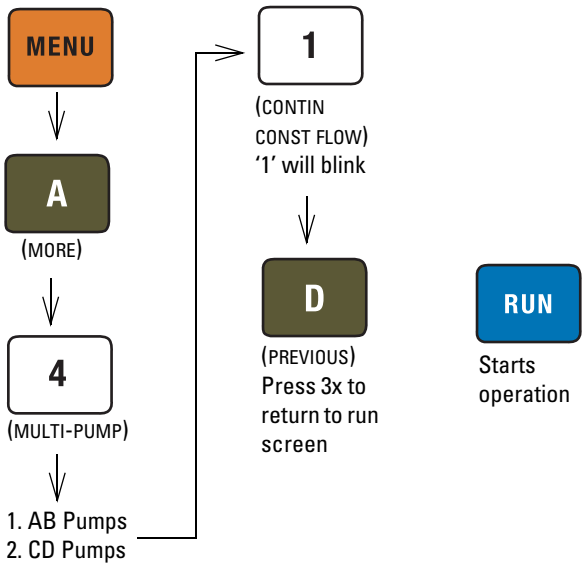


Figure 5-10 Keystrokes to set up constant flow

5.6.3 Constant Pressure Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

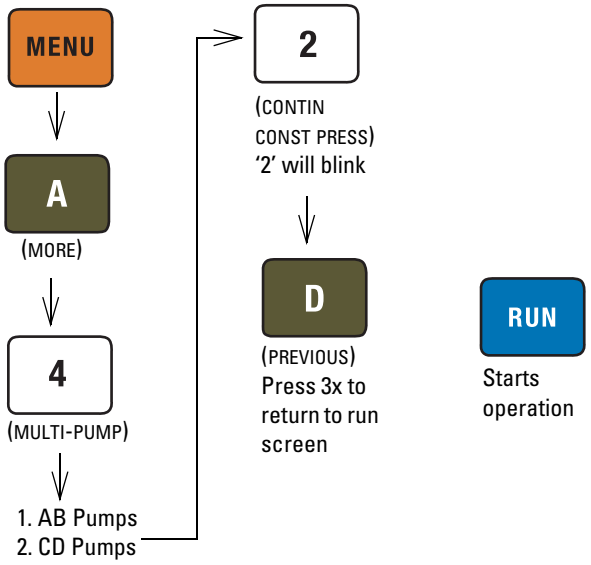


Figure 5-11 Keystrokes to set up constant pressure

5.6.4 No Check Valve

To limit fluid backflow from the pump to the supply reservoir one of two approaches is generally used. Either a check valve is installed in the supply line or the NO CHECK VALVE (NCV) software feature is enabled on the controller.

The NO CHECK VALVE (NCV) feature controls the opening of the inlet valves such that, just prior to refill, the pump is depressurized to a user-specified value (pressure point) or until a user-specified time out period (time point). This reduces pressure in the cylinder before the inlet valve is opened.

The NCV software feature is disabled by default; however, if no check valve is installed on the supply line, it is recommended that this feature is enabled.

> **Note**
>
> A check valve is not provided for Ball Valve Packages. It is recommended to turn ON the NCV feature before operating the valves.

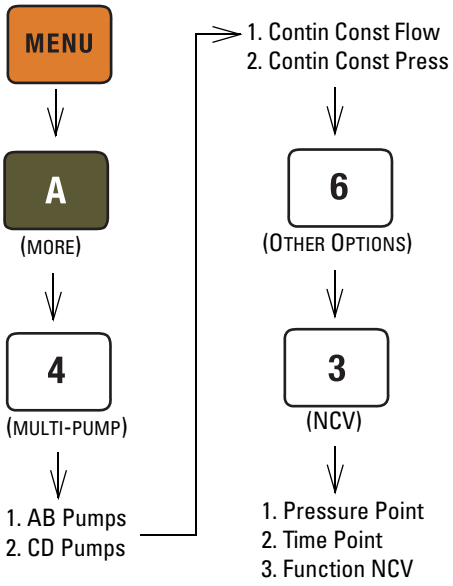


Figure 5-12 Keystrokes to set up No Check Valve

5.6.5 To Run or Stop

This menu setting allows the operator to run or stop both pairs of pumps simultaneous.

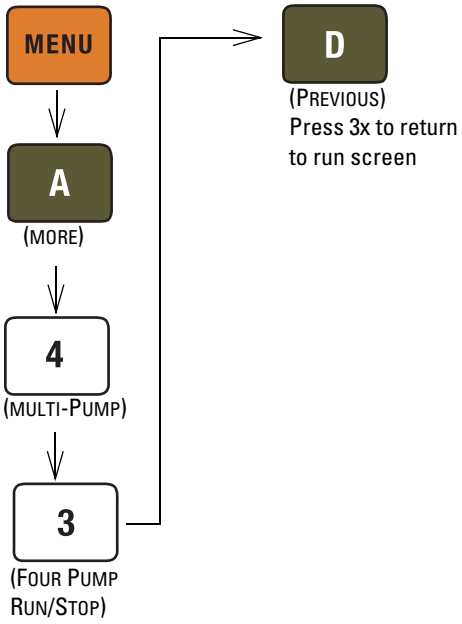


Figure 5-13 Keystrokes to Run or Stop the pumps

> **Note**
> Before pressing RUN, ensure that ON CONT FLOW is displayed on the screen, and that the set flow rate/pressure is correct.

Always verify the valve settings before running a program. If a controller is reset or moved to a different power source, it will revert back to default settings (Active).

5.6.6 Tips for Running Continuous Flow

Liquids Checklist:

1. Degas liquids if appropriate.
2. Purge air from the system:
   a. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
   b. Route the outlet to waste or reservoir and press RUN. Press STOP when fluid comes out of the outlet.
   c. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
   d. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
   e. Connect the outlet tubing and fill each pump once more.
3. Reset total volume (see Figure 5-9).

Liquefied Gases Checklist:

1. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
2. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
3. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
4. Pressurize both pumps by pressing RAPID PRESS. Maximum flow rate and target pressure value will be displayed. Press D to continue pressurization.
5. Reset total volume (see Figure 5-9).

Equilibration – When the pumps begin running, the system will go through an equilibration phase, during which both pumps must be full and delivering fluid.

Additional guidelines – Please become familiar with the following guidelines:

- Pressure limits for continuous constant flow mode are set by the limits of pump A for the A-B pair and pump C for the C-D pair.
- Temperature changes can cause pressure fluctuations. For available temperature control options, contact Teledyne Isco.
- For correct overpressure response, shutdown must be set to ON under PUMP LIMIT options.
- Enter the same refill rate separately for pumps A, B, C, and D.
  The refill rate should always be as high as possible to allow time for refill and repressurization before the next switchover.

D Series Syringe Pumps

Section 6 Modifier Addition

6.1 Overview

Pumping systems using a modifier (usually a solvent) may have different configurations, depending on the application, including:

- Two separate pumps delivering a mixture of supercritical fluid and modifier to one or more user-provided extractors.
- A dual pump system in constant pressure mode pumping supercritical fluid, with a third pump delivering the modifier.

> ☑ ***Note***
>
> This is not available for the 30D pump. Please contact the factory for details.

In both configurations, the purpose is to dispense a mixture with a programmable v/v ratio. Modifier concentrations of up to 100% can be programmed. Both fluids pass through one-way check valves before they meet and are blended in a static mixing tee (refer to Figures 6-1 and 6-2).

> ⚠ **DANGER**
>
> **Risk of injury. The pressure produced could be up to 700 bar. Please utilize appropriate tubing and connections as noted.**

> ☑ ***Note***
>
> The configurations described in this section apply to 65DM, 100DM, 100DX, 260D, 500D, and 1000D pumps that use Valco or SSI fittings.
> The 65D pump can be configured and operated in a similar manner. However, due to the higher operating pressure and the AE F250C fittings, the 65D requires hardware that is not listed in this section. Call the factory for details to configure a 65D pump for this type of operation.

6.1.1 Installing the Kit

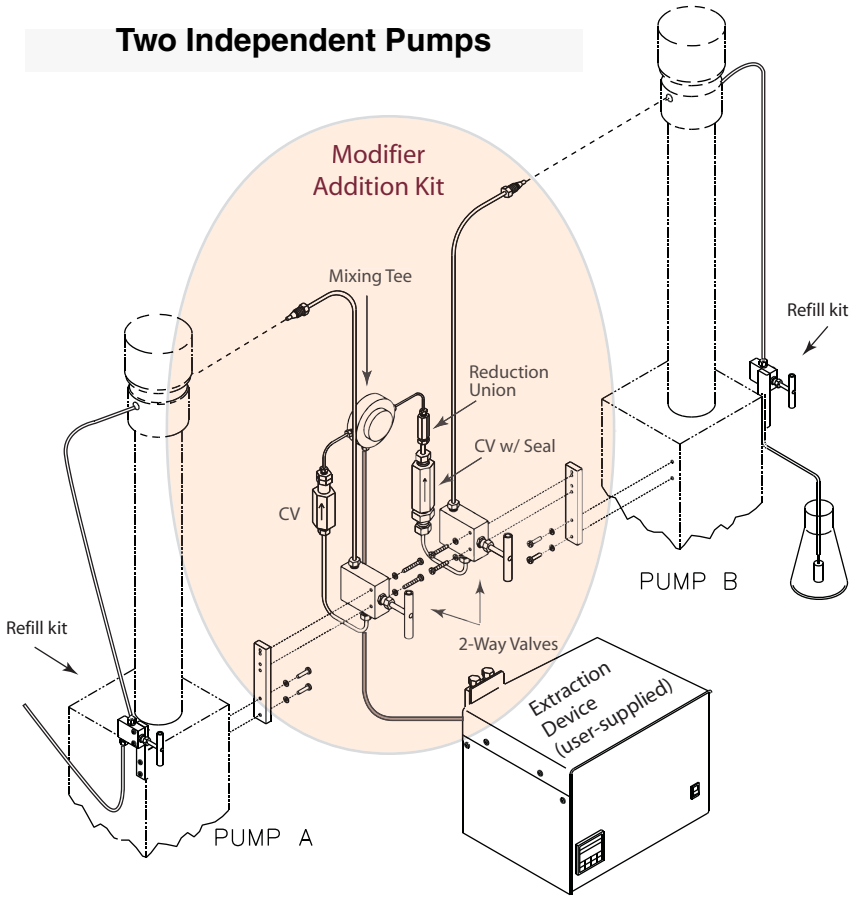
The mixing tee union fitting, check valves, and SST tubing are pre-assembled. The only connections you have to make are to the pump outlet ports and outlet tubing from the tee to your apparatus (tubing not provided).

Note

Tighten fittings just enough to hold tubing in place. Final tightening will be done after all tubing and fittings are connected.

The following installation steps refer to Figure 6-1 (independent pumps) or Figure 6-2 (continuous flow system).

The PTFE tubing (part #023-0504-02) and filter (part #209-9012-10) from the syringe pump refill kit should be connected to the inlet valve of pump B.



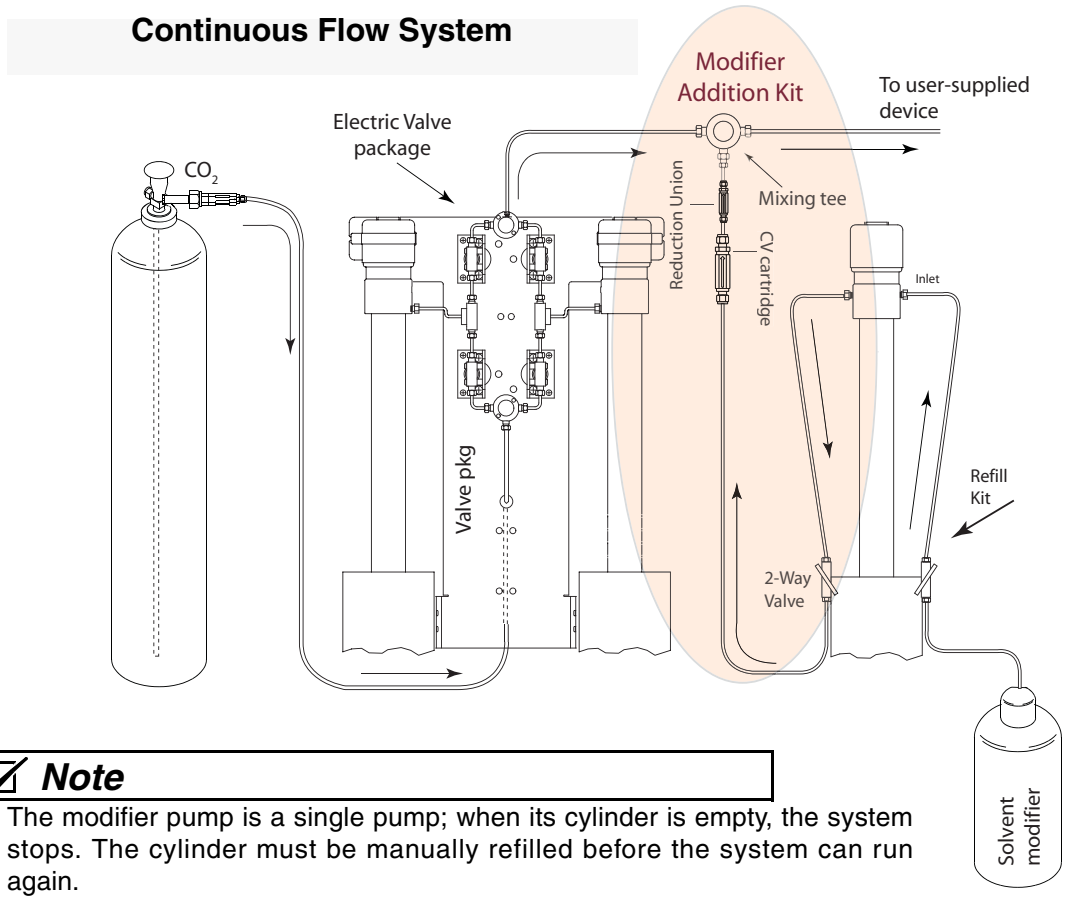
1. Attach a 2-way valve to each pump housing, using the spacer block and screws.
2. Attach the pump outlet tubing/two-way valve assembly to each pump outlet.
3. Attach the 10.2cm pre-bent SST tubing from the check valve inlet to the two-way valve outlet.
4. Connect your tubing from the tee outlet to your equipment.
5. Tighten all fittings.

Tubing for connection to user equipment is not provided. Optional 1/16" and 1/8" OD SST tubing may be ordered from Teledyne Isco.

Figure 6-1 Modifier addition kit installation (Two-pump configuration)

Table 6-1 contains modifier addition kit components for connecting the outlets of two pumps, using a Valco 1/16" tee as a mixer.

Table 6-1 Modifier Addition Kit for Two Pumps (part #68-1247-079)					
Description	**Part Number**	**Description**	**Part Number**	**Description**	**Part Number**
Tee union fitting 1/16”	209-0169-47	1/8” nut (4)	209-0169-27	Check valve cartridge 1/8”	209-0161-80
1/16” OD × 12 cm tubing	60-1243-540	1/16” OD × 1.5 m tubing	60-1243-539	Check valve/mixer tubing	60-1243-691
1/16” Ferrule	209-0169-34	Valve spacer (2)	60-1243-659	Appropriate screws and washers also included.	
1/16” Gland nut	209-0169-35	2-way valve - 1/8” OD (2)	209-0098-05		
Standard check valve housing	60-2253-209	Tubing, valve inlet (2)	60-1243-658		
Check valve cartridge	60-3864-010	Tubing, check valve (2)	60-1243-644		
Single check valve housing	60-1243-516	Reduction union	209-0162-10		
1/8” Ferrule, zero vol (4)	209-0169-41	1/8”OD x 2.57 SST tubing	60-1243-570		



Note

The modifier pump is a single pump; when its cylinder is empty, the system stops. The cylinder must be manually refilled before the system can run again.

Figure 6-2 Modifier addition kit installation (continuous flow)

Table 6-2 contains modifier addition components for connecting to a continuous flow system.

Table 6-2 Modifier Addition Components for Continuous Flow System

Description	Part Number
Tee union fitting 1/16"	209-0169-47
Check valve cartridge	60-3864-010
Single check valve housing	60-1243-516
Tubing, check valve	60-1243-644
2-way valve - 1/8" OD	209-0098-05
Tubing, valve inlet	60-1243-658
Reduction union 1/8" to 1/16"	209-0162-10
Valve spacer	60-1243-659
1/16" OD × 12 cm tubing	60-1243-540
1/8"OD x 2.57 SST tubing	60-1243-570
Check valve cartridge 1/8"	209-0161-80
Check valve/mixer tubing	60-1243-691

6.1.2 Modifier Mode Setup

When first setting up a system for modifier mode, the pumps should be zeroed and filled. To accomplish this, the pumps should first be placed under independent control - constant pressure mode.

> ☑ ***Note***
>
> Once the modifier system is operating, the system does not need to be zeroed before refilling.

1. If the pumps are running, press the STOP key once.
2. Press MENU > MORE (A).
3. Press 4 - MULTI-PUMP, to display the multi-pump menu.
4. Press 4 - INDEPENDENT to designate that the pumps be operated under independent control. The number 4 will blink, indicating that Independent Mode has been selected.
5. Press D - PREVIOUS, twice to return to the main menu.
6. Press CONST PRESS.

To zero the pumps

1. Place the pumps in independent control - constant pressure mode, as detailed above.
2. Be sure the pumps are stopped.
3. Disconnect the inlet tubing from the inlet valve of pump A.
4. Select 2 pump independent control/constant pressure mode. Refer to Section 5.6 *Continuous Flow Mode*.

5. Open the inlet valves of each pump.
6. Run both pumps empty.
7. Zero the pressure on each pump.
8. Reconnect the pump A inlet tubing to the inlet valve.

To fill pump B with modifier

1. Place the pumps in independent control - constant pressure mode, as previously explained. Be sure the pumps are stopped.
2. Close the pump B outlet valve and open the pump B inlet valve.
3. Press REFILL. Press softkey B to designate that pump B is the active pump (the pump being refilled). Pump B will fill with modifier.
4. After pump B has filled, press run and deliver 5-10 ml of modifier back through the inlet valve, to ensure all air is purged from the pump, before pressing stop.
5. Close the inlet valve.

☑ Note

When using the pumps with liquefied CO_2, make sure you purchase CO_2 in a "dip-tube" CO_2 tank.

To fill pump A with supercritical fluid (helium head-space tank)

1. Place the pumps in independent control - constant pressure mode, as detailed above.
2. Be sure the pumps are stopped.
3. Close the pump A outlet valve before opening the tank supply valve and pump A inlet valve.
4. Press REFILL. Press softkey A to designate that pump A is the active pump (the pump being refilled). Pump A will fill with pressurized fluid.
5. After pump A has refilled, wait 15 seconds before closing the tank supply valve and pump A inlet valve.

6.1.3 Two Pump Operation

Pump A delivers supercritical fluid while pump B meters modifier. Both fluids pass through one-way check valves before they meet and are blended together in a mixing tee. Modifier concentrations of up to 100 percent (v/v) are programmable via the controller. If higher concentrations are needed, put the modifier in pump A to be delivered as the primary fluid.

Both pumps operate in constant pressure mode and will flow up to their maximum rate to maintain the set pressure. When modifier addition mode is selected and RUN is pressed, pump A pressure is ramped at its maximum flow rate to the set pressure while pump B waits at a lower pressure (3.5 bar).

Pump B minimum pressure can be increased if the modifier boils at room temperature and 3.5 bar.

Once pump A has reached the set pressure, the controller will enter a hold mode and wait for a pressure drop. The start of EQUILIBRATION is signaled by opening the extractor inlet, or pressing RUN.

> **☑ Note**
>
> Flow must then be started through the system by opening all valves! The modifier pump will not equilibrate properly without flow.

Pump B pressure is then slowly ramped upward until its check valve is detected as open. At this point, the controller exits EQUILIBRATION mode and displays the message RUNNING.

When RUNNING is displayed, the controller monitors pump A piston movement, and calculates the pump B piston movement required to deliver the correct ratio of modifier. If pump A cannot maintain the set pressure, as when the extraction cartridges are initially filling or pump A is refilling, the controller reverts to EQUILIBRATION and pump B pressure is dropped below that of pump A to avoid delivery of incorrect modifier concentrations. Once the pump A set pressure is reestablished, the system will re-equilibrate.

When pump B needs refilling, it must first be placed under independent control, as you must run it to return 5-10 ml of modifier back through the valve to be sure that the cylinder is free of air.

> **☑ Note**
>
> To properly equilibrate the pumps, they must be delivering fluid.

When preparing your system for modifier operation, if you are connecting pump A to a CO_2 tank, you will need to use the stainless steel tubing (P/N 60-1243-391) and appropriate CO_2 connecting fittings. If you do not have these fittings, a CO_2 cylinder connection package (P/N 68-1247-043) may be ordered from Teledyne Isco.

6.2 Programming

Once the pressure has been zeroed and the pumps are filled, you are ready to set up your modifier addition parameters. You will need to place the pumps in modifier mode, set the pressure limits (under the limits option on the main menu) and designate the percent of modifier (found under % pump on the run screen) to be added. If your modifier boils at 3.5 bar at room temperature, you may want to increase the minimum pressure for pump B to prevent vapor (the default minimum pressure is 3.5 bar).

Before operation in modifier mode, zero and fill the pumps under independent control/constant pressure mode.

Once the pumps are ready, place them in modifier mode:

Press MENU > MORE (A) > MULTI-PUMP (4), and select CONTIN MODIFIER (5).

6.2.1 Mininum Modifier Pressure Setting

The default setting for the minimum modifier pump pressure is 50PSI. This can be changed to a value appropriate for the type of modifier being used.

If there is no need to change minimum pressure, press PREVIOUS (D) three times to return to the main menu. The screen will display the words PRESSURE MODIFIER.

To change the minimum pressure:

Press MIN MOD PRESS (B).

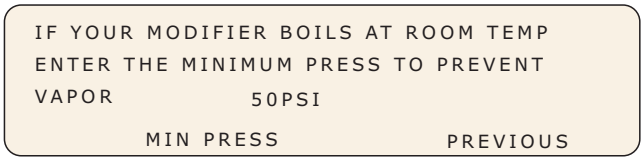


Figure 6-3 Minimum modifier pressure screen

Select MIN PRESS (B). "ENTER MIN PRES" will flash. Type the desired pressure value and then press ENTER.

Press PREVIOUS (D) four times to return to the main menu. The screen will display the words PRESSURE MODIFIER.

6.2.2 Modifier Concentration

To set the modifier concentration, press % PUMP (C), or %PUMP B or C. Use the numeric keys to enter the desired percentage of modifier and press ENTER to save the value.

To select the limits

1. Once modifier mode has been selected, the desired pressure limits must be set. Select number 2, LIMITS, from the main menu.
2. The pump for which the limits are being set will be shown on the top left of the display, LIMITS: PUMP A. If it is any pump other than pump A, press A. LIMITS: PUMP A will then be displayed.
3. Press number 1 to select LIMITS and then 1 again to set the MAX pressure limits. Enter the desired maximum pressure using the numeric keypad and press ENTER to store the value. Then press D, PREVIOUS, to return to the limits menu.
4. If you need to change the minimum pressure limit, press 2 - MIN. Enter the desired minimum pressure using the numeric keypad and press ENTER to store the value.
5. Press D, PREVIOUS, to return to the Limits menu.
6. Continue pressing D to return to the run screen.
7. MODIFIER ON will be displayed above softkey B, and % PUMP will be displayed above softkey C. To designate the desired modifier concentration, press C. Then use the numeric keys to enter the desired percentage of modifier. Press ENTER to save the desired value.

8. Open the outlet valves of both pumps if they are not open.
9. Press RUN.
10. When the pressure for Pump A is established, the message "HOLD: PRESS RUN" will be displayed.
11. Open the extractor inlet valves.
12. The message "EQUILIBRATE" will be displayed on the controller screen. If the controller does not display "EQUILIBRATE," press RUN. While this message is displayed, no modifier will be delivered.
13. Immediately open the extractant outlet valve(s).

> ☑ ***Note***
>
> Flow MUST be established through the system at or before the time "EQUILIBRATE" is displayed. To properly equilibrate the pumps, they must be delivering fluid.

14. Once the message RUNNING is displayed, modifier will be delivered at the selected rate.

6.3 Refilling

Once your modifier addition system is running, you will occasionally need to refill the pumps. The system must be stopped while the pumps are refilling. Pump A, the "CO_2" pump, may be refilled simply by designating the pump to be refilled and then pressing REFILL (refer to instructions below). Pump B, "the modifier pump", may also be refilled in this manner. However, if you wish to ensure that air is purged from pump B, it must be placed under independent control before refilling. Once under independent control, the pump will run until 5-10 ml of modifier are delivered back to the source (see refilling pump B below).

To refill the CO_2 pump

1. Press STOP.
2. Close the outlet valves of both pumps.
3. Press REFILL, and press A to designate pump A.
4. As soon as the pump pressure drops below the known tank pressure, open the tank supply valve and the pump A inlet valve.
5. After pump A has refilled, the message CYLINDER FULL will be displayed on the controller front panel. Wait 15 seconds before closing the tank supply valve and the pump A inlet valve.
6. Open the outlet valves of both pumps.
7. Press RUN.
8. When A pressure is established, the message HOLD: PRESS RUN will be displayed.
9. Open the extractor inlet valves.
10. The message EQUILIBRATE will be displayed on the controller screen. If the controller does not display EQUILIBRATE, press RUN. While this message is displayed, no modifier will be delivered.

11. Immediately open the extractant outlet valve(s).

☑ Note

Flow MUST be established through the system at or before the time EQUILIBRATE is displayed. To properly equilibrate the pumps, they must be delivering fluid.

12. Once the message RUNNING is displayed, modifier will be delivered at the selected rate.

To refill pump B (the modifier pump)

1. Press STOP.
2. Close the outlet valves of both pumps.
3. Take the pumps out of modifier mode by pressing softkey B under the word MODIFIER. The word ON will change to OFF.
4. Open the inlet valve of pump B.
5. Press REFILL, and press B to designate Pump B.
6. After pump B has filled, press CONST FLOW and set the desired purging flow rate. Press RUN and deliver 5-10 ml of modifier back through the inlet valve. This ensures that all air is purged from the pump.
7. Press STOP> B.

To start modifier

1. Return to constant pressure mode by pressing D, SELECT PUMP, and then A.
2. Place the pump in modifier mode by pressing softkey B under the words MODIFIER. The word OFF will change to ON above MODIFIER.
3. Open the outlet valves of both pumps if they are not open.
4. Press RUN.
5. When A pressure is established, the message HOLD: PRESS RUN will be displayed.
6. Open the extractor inlet valves.
7. The message EQUILIBRATE will be displayed on the controller screen. If the controller does not display EQUILIBRATE, press RUN. While this message is displayed, no modifier will be delivered.
8. Immediately open the extractant outlet valve(s).

☑ Note

Flow MUST be established through the system at or before the time EQUILIBRATE is displayed. To properly equilibrate the pumps, they must be delivering fluid.

9. Once the message RUNNING is displayed, modifier will be delivered at the selected rate.

D Series Syringe Pumps

Section 7 Modbus Configuration

7.1 Overview

Modbus is a simple command/response mechanism to read from and write to specific memory locations called *registers*. A register is a holding place for a piece of digital information within the equipment. For more information on Modbus, please refer to the following documents which can be found on the www.modbus.org website: Modbus Application Protocol Vol. 1 and Modbus Over Serial Line Vol. 1[2] and Modbus Messaging on TCP/IP.

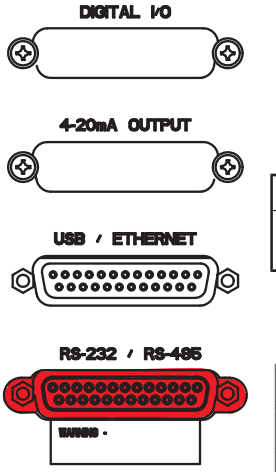
The Isco D Series Syringe pump controller supports the Modbus RTU and Modbus TCP/IP protocols.

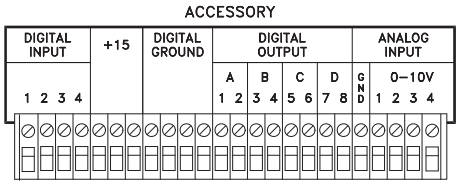
7.1.1 Modbus RTU

The Modbus RTU protocol implementation uses a 2-wire RS-485 connection. The RS-485 connections are located on the DB25 connector labeled RS-232/RS-485. We recommend connecting the ground reference wire as shown in Figure 7-1. The matching connection is a D-Subminiature 25-pin standard plug, such as an AMP part #747912-2 from an electronic parts supplier.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.





Pin on DB25-shell	RS-485 2-Wire
18	DATA (B)+
11	DATA (A)-
7	GND

Figure 7-1 RS-485 Connection

7.1.2 Modbus TCP/IP

The modbus TCP/IP protocol implementation uses an ethernet connection. The ethernet connections are located on the optional DB25 connector labeled USB/Ethernet. Use optional cable (PN 60-1244-488) and coupler (PN 14-9905-200) to connect to your Ethernet.

Pin on DB 25 Casing	Ethernet	RJ-45
2	Transmit +	1
14	Transmit -	2
15	Receive +	3
17	Receive -	6
22	Vgnd	4+5
23	Vgnd	7+8

7.1.3 Modbus Configuration Options

To access the Modbus configuration settings, press:

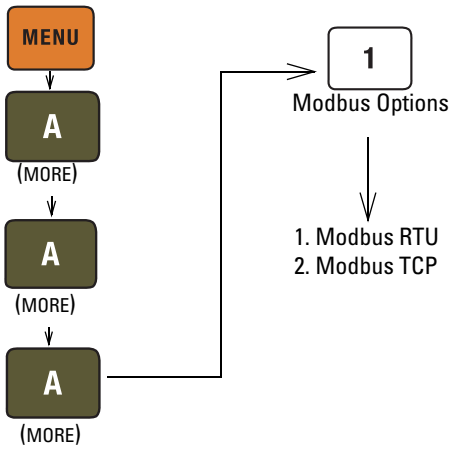


Table 7-1 Modbus TCP/IP Configuration Options

Item	Description
IP Address	Internet protocol address of device (Default 192.168.1.200)
Subnet Mask	Subnet mask (Default 255.255.255.0)
Gateway	Gateway (Default 0.0.0.0)
Port	TCP port (Default 502)

Table 7-2 Modbus RTU Configuration Options

Item	Value	Description
Baud Rate	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	Communication Speed (Default 19200)
Slave ID	1-247	Device address (Default 1)

Table 7-2 Modbus RTU Configuration Options		
Parity	Even 1 Stop Bit, Odd 1 Stop Bit, None 1 Stop Bit, None 2 Stop Bit	Communication parameters (Default Even 1 Stop Bit)
Word Order	Big Endian, Little Endian	Word order for 32-bit integers and IEEE-754 floating point numbers. Big Endian: AB CD; Little Endian CD AB. (Default Big Endian)
Character Time	Min: Baud Rate dependent Max: 999ms	Time to transmit single character t1. Used to calculate inter frame and inter character space t1.5, t3.5 (50 m sec default)

Table 7-3 Supported Modbus Function Codes	
Function Code	**Description**
01	Read Discrete Output Coils
03	Read Analog Output Holding Registers
05	Write Single Discrete Output Coil
15	Write Multiple Discrete Output Coils
16	Write Multiple Analog Output Holding Registers

Table 7-4 Exception Responses		
Exception Code	**Name**	**Description**
01	Illegal Function	Function code received is not supported.
02	Illegal Data Address	Data address received is not an allowable address.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the addressed location. This may indicate a fault in the structure of the remainder of a complex request, such that the implied length is incorrect. Does NOT mean data value is outside the expectation of the controller.

Table 7-5 Coils

Register	Address	Type	Size	Description
00001	0	R/W	1 BIT	0: Stop Pump A 1: Run Pump A
00002	1	R/W	1 BIT	0: Stop Pump B 1: Run Pump B
00003	2	R/W	1 BIT	0: Stop Pump C 1: Run Pump C
00004	3	R/W	1 BIT	0: Stop Pump D 1: Run Pump D
00005	4	R/W	1 BIT	Link Run/Stop operation of multi-pump pair AB & multi-pump pair CD 0: Disable 1:Enable
00006	5	R/W	1 BIT	0: Stop Pump A if in Refill 1: Run Pump A in Refill
00007	6	R/W	1 BIT	0: Stop Pump B if in Refill 1: Run Pump B in Refill
00008	7	R/W	1 BIT	0: Stop Pump C if in Refill 1: Run Pump C in Refill
00009	8	R/W	1 BIT	0: Stop Pump D if in Refill 1: Run Pump D in Refill
00010	9	R/W	1 BIT	1: Pump A in Constant Pressure mode
00011	10	R/W	1 BIT	1: Pump B in Constant Pressure mode
00012	11	R/W	1 BIT	1: Pump C in Constant Pressure mode
00013	12	R/W	1 BIT	1: Pump D in Constant Pressure mode
00014	13	R/W	1 BIT	1: Pump A in Constant Flow mode
00015	14	R/W	1 BIT	1: Pump B in Constant Flow mode
00016	15	R/W	1 BIT	1: Pump C in Constant Flow mode
00017	16	R/W	1 BIT	1: Pump D in Constant Flow mode
00018	17	R/W	1 BIT	1: Pump A & Pump B in Independent mode
00019	18	R/W	1 BIT	1: Pump A & Pump B in Continuous Flow Constant Flow mode
00020	19	R/W	1 BIT	1: Pump A & Pump B in Continuous Flow Constant Pressure mode
00021	20	R/W	1 BIT	1: Pump A & Pump B in Modifier addition mode
00022	21	R/W	1 BIT	1: Pump A & Pump B & Pump C in Continuous Modifier addition mode
00023	22	R/W	1 BIT	1: Pump C & Pump D in Independent mode
00024	23	R/W	1 BIT	1: Pump C & Pump D in Continuous Flow Constant Flow mode
00025	24	R/W	1 BIT	1: Pump C & Pump D in Continuous Flow Constant Pressure mode
00026	25	R/W	1 BIT	0:Multi-pump pair AB in Delivery mode 1: Multi-pump pair AB in Receive mode
00027	26	R/W	1 BIT	0: Multi-pump pair AB in Low Press operation 1: Multi-pump pair AB in Normal Press operation
00028	27	R/W	1 BIT	0: Use Fast (coarser) pressure match control for multi-pump pair AB 1: Use Normal (finer) pressure match control for multi-pump pair AB
00029	28	R/W	1 BIT	0: Multi-pump pair CD in Delivery mode 1: Multi-pump pair CD in Receive mode
00030	29	R/W	1 BIT	0: Multi-pump pair CD in Low Press operation 1: Put multi-pump pair CD in Normal Press operation
00031	30	R/W	1 BIT	0: Use Fast (coarser) pressure match control for multi-pump pair CD 1: Use Normal (finer) pressure match control for multi-pump pair CD
00032	31	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump A
00033	32	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump B
00034	33	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump C
00035	34	R/W	1 BIT	1: Activates the automatic rapid pressurization cycle (Constant Flow mode only) for Pump D
00036	35	R	1 BIT	1: Pump A is Equilibrating
00037	36	R	1 BIT	1: Pump B is Equilibrating

Table 7-5 Coils (Continued)

Register	Address	Type	Size	Description
00038	37	R	1 BIT	1: Pump C is Equilibrating
00039	38	R	1 BIT	1: Pump D is Equilibrating
00040	39	R	1 BIT	1: Pump A is in Hold (clock stopped)
00041	40	R	1 BIT	1: Pump B is in Hold (clock stopped)
00042	41	R	1 BIT	1: Pump C is in Hold (clock stopped)
00043	42	R	1 BIT	1: Pump D is in Hold (clock stopped)
00044	43	R	1 BIT	1: Pump A & Pump B in Concentration Gradient
00045	44	R	1 BIT	1: Pump A in Pressure Gradient
00046	45	R	1 BIT	1: Pump A in Flow Gradient
00047	46	R/W	1 BIT	1: Controller in Local Operation
00048	47	R/W	1 BIT	1: Controller in Remote Operation
00049	48	R/W	1 BIT	1: Controller in External Operation
00050	49	R/W	1 BIT	1: External Refill control enabled
00051	50	R/W	1 BIT	1: Zero pressure sensor offset for Pump A
00052	51	R/W	1 BIT	1: Zero pressure sensor offset for Pump B
00053	52	R/W	1 BIT	1: Zero pressure sensor offset for Pump C
00054	53	R/W	1 BIT	1: Zero pressure sensor offset for Pump D
00055	54	R/W	1 BIT	0: Pressure Integrator for Pump A OFF 1: Pressure Integrator for Pump A ON
00056	55	R/W	1 BIT	0: Pressure Integrator for Pump B OFF 1: Pressure Integrator for Pump B ON
00057	56	R/W	1 BIT	0: Pressure Integrator for Pump C OFF 1: Pressure Integrator for Pump C ON
00058	57	R/W	1 BIT	0: Pressure Integrator for Pump D OFF 1: Pressure Integrator for Pump D ON
00059	58	R/W	1 BIT	0: Pressure Deadband for Pump A OFF 1: Pressure Deadband for Pump A ON
00060	59	R/W	1 BIT	0: Pressure Deadband for Pump B OFF 1: Pressure Deadband for Pump B ON
00061	60	R/W	1 BIT	0: Pressure Deadband for Pump C OFF 1: Pressure Deadband for Pump C ON
00062	61	R/W	1 BIT	0: Pressure Deadband for Pump D OFF 1: Pressure Deadband for Pump D ON
00063	62	R/W	1 BIT	0: AUTO REFILL A OFF 1: AUTO REFILL A ON
00064	63	R/W	1 BIT	0: AUTO REFILL B OFF 1: AUTO REFILL B ON
00065	64	R/W	1 BIT	0: AUTO REFILL C OFF 1: AUTO REFILL C ON
00066	65	R/W	1 BIT	0: AUTO REFILL D OFF 1: AUTO REFILL D ON
00067	66	R/W	1 BIT	0: AUTO FILL A OFF 1: AUTO FILL A ON
00068	67	R/W	1 BIT	0: AUTO FILL B OFF 1: AUTO FILL B ON
00069	68	R/W	1 BIT	0: AUTO FILL C OFF 1: AUTO FILL C ON
00070	69	R/W	1 BIT	0: AUTO FILL D OFF 1: AUTO FILL D ON
00071	70	R/W	1 BIT	0: DIGITAL OUTPUT BIT 1 HIGH 1: DIGITAL OUTPUT BIT 1 LOW
00072	71	R/W	1 BIT	0: DIGITAL OUTPUT BIT 2 HIGH 1: DIGITAL OUTPUT BIT 2 LOW
00073	72	R/W	1 BIT	0: DIGITAL OUTPUT BIT 3 HIGH 1: DIGITAL OUTPUT BIT 3 LOW
00074	73	R/W	1 BIT	0: DIGITAL OUTPUT BIT 4 HIGH 1: DIGITAL OUTPUT BIT 4 LOW
00075	74	R/W	1 BIT	0: DIGITAL OUTPUT BIT 5 HIGH 1: DIGITAL OUTPUT BIT 5 LOW
00076	75	R/W	1 BIT	0: DIGITAL OUTPUT BIT 6 HIGH 1: DIGITAL OUTPUT BIT 6 LOW
00077	76	R/W	1 BIT	0: DIGITAL OUTPUT BIT 7 HIGH 1: DIGITAL OUTPUT BIT 7 LOW

Table 7-5 Coils (Continued)

Register	Address	Type	Size	Description
00078	77	R/W	1 BIT	0: DIGITAL OUTPUT BIT 8 HIGH 1: DIGITAL OUTPUT BIT 8 LOW
00079	78	R/W	1 BIT	0: Disable Dispense Mode A 1: Enable Dispense Mode A Only configure if in Constant Flow Mode
00080	79	R/W	1 BIT	0: Disable Dispense Mode B 1: Enable Dispense Mode B Only configure if in Constant Flow Mode
00081	80	R/W	1 BIT	0: Disable Dispense Mode C 1: Enable Dispense Mode C Only configure if in Constant Flow Mode
00082	81	R/W	1 BIT	0: Disable Dispense Mode D 1: Enable Dispense Mode D Only configure if in Constant Flow Mode
00083	82	R/W	1 BIT	1: Reset total volume delivered by multi-pump pair AB
00084	83	R/W	1 BIT	1: Reset total volume delivered by multi-pump pair CD
00085	84	R/W	1 BIT	1: Pressure Units =ATM
00086	85	R/W	1 BIT	1: Pressure Units = BAR
00087	86	R/W	1 BIT	1: Pressure Units = kPa
00088	87	R/W	1 BIT	1: Pressure Units = PSI
00089	88	R/W	1 BIT	1: Flow Units = ml/min
00090	89	R/W	1 BIT	1: Flow Units = ml/hr
00091	90	R/W	1 BIT	1: Flow Units = ul/min
00092	91	R/W	1 BIT	1: Flow Units = ul/hr
00093	92	R/W	1 BIT	0: Overpressure Alarm OFF 1: Overpressure Alarm ON
00094	93	R/W	1 BIT	0: Overpressure Display OFF 1: Overpressure Display ON
00095	94	R/W	1 BIT	0: Overpressure Shutdown OFF 1: Overpressure Shutdown ON
00096	95	R/W	1 BIT	0: Underpressure Alarm OFF 1: Underpressure Alarm ON
00097	96	R/W	1 BIT	0: Underpressure Display OFF 1: Underpressure Display ON
00098	97	R/W	1 BIT	0: Underpressure Shutdown OFF 1: Underpressure Shutdown ON
00099	98	R/W	1 BIT	0: Overflow Alarm OFF 1: Overflow Alarm ON
00100	99	R/W	1 BIT	0: Overflow Display OFF 1: Overflow Display ON
00101	100	R/W	1 BIT	0: Overflow Shutdown OFF 1: Overflow Display ON
00102	101	R/W	1 BIT	0: Underflow Alarm OFF 1: Underflow Alarm ON
00103	102	R/W	1 BIT	0: Underflow Display OFF 1: Underflow Display ON
00104	103	R/W	1 BIT	0: Underflow Shutdown OFF 1: Underflow Shutdown ON
00105	103	R/W	1 BIT	0: Poor Fill Alarm A OFF 1: Poor Fill Alarm A ON
00106	105	R/W	1 BIT	0: Poor Fill Alarm B OFF 1: Poor Fill Alarm B ON
00107	106	R/W	1 BIT	0: Poor Fill Alarm C OFF 1: Poor Fill Alarm C ON
00108	107	R/W	1 BIT	0: Poor Fill Alarm D OFF 1: Poor Fill Alarm D ON
00109	108	R/W	1 BIT	1: Stop all motor and reset flow rate and pressure set-points to default.
00110	109	R	1 BIT	0: Transducer of Pump A not connected 1: Transducer of Pump A connected
00111	110	R	1 BIT	0: Pump A not at upper flag limit 1: Pump A at upper Flag Limit (Empty)
00112	111	R	1 BIT	0: Pump A not at lower flag limit 1: Pump A at lower flag limit (Full)
00113	112	R	1 BIT	1: Pump A is overpressure
00114	113	R	1 BIT	1: Pump A is underpressure

Table 7-5 Coils (Continued)

Register	Address	Type	Size	Description
00115	114	R	1 BIT	1: Motor failure Pump A
00116	115	R	1 BIT	0: Transducer of Pump B not connected 1: Transducer of Pump B connected
00117	116	R	1 BIT	0: Pump B not at upper flag limit 1: Pump B at upper Flag Limit (Empty)
00118	117	R	1 BIT	0: Pump B not at lower flag limit 1: Pump B at lower flag limit (Full)
00119	118	R	1 BIT	1: Pump B is overpressure
00120	119	R	1 BIT	1: Pump B is underpressure
00121	120	R	1 BIT	1: Motor failure Pump B
00122	121	R	1 BIT	0: Transducer of Pump C not connected 1: Transducer of Pump C connected
00123	122	R	1 BIT	0: Pump C not at upper flag limit 1: Pump C at upper Flag Limit (Empty)
00124	123	R	1 BIT	0: Pump C not at lower flag limit 1: Pump C at lower flag limit (Full)
00125	124	R	1 BIT	1: Pump C is overpressure
00126	125	R	1 BIT	1: Pump C is underpressure
00127	126	R	1 BIT	1: Motor failure Pump C
00128	127	R	1 BIT	0: Transducer of Pump D not connected 1: Transducer of Pump D connected
00129	128	R	1 BIT	0: Pump D not at upper flag limit 1: Pump D at upper Flag Limit (Empty)
00130	129	R	1 BIT	0: Pump D not at lower flag limit 1: Pump D at lower flag limit (Full)
00131	130	R	1 BIT	1: Pump D is overpressure
00132	131	R	1 BIT	1: Pump D is underpressure
00133	132	R	1 BIT	1: Motor failure Pump D
00134	133	R	1 BIT	1: POOR FILL A ERROR
00135	134	R	1 BIT	1: POOR FILL B ERROR
00136	135	R	1 BIT	1: POOR FILL C ERROR
00137	136	R	1 BIT	1: POOR FILL D ERROR
00138	137	R	1 BIT	1: VALVE ERROR
00139	138	R	1 BIT	DIGITAL IN 1
00140	139	R	1 BIT	DIGITAL IN 2
00141	140	R	1 BIT	DIGITAL IN 3
00142	141	R	1 BIT	DIGITAL IN 4

Table 7-6 Holding Registers

Register	Address	Read/ Write	Type	# of Registers	Description	Units
40001	0	R/W	FLOAT	2	Pressure set-point for Pump A in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40003	2	R/W	FLOAT	2	Pressure set-point for Pump B in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40005	4	R/W	FLOAT	2	Pressure set-point for Pump C in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40007	6	R/W	FLOAT	2	Pressure set-point for Pump D in Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.

Table 7-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40009	8	R/W	FLOAT	2	Pressure set-point for multi-pump pair AB in Continuous Flow Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40011	10	R/W	FLOAT	2	Pressure set-point for multi-pump pair CD in Continuous Flow Constant Pressure mode.	ATM; BAR; kPa; PSI See NOTE 1.
40013	12	R/W	FLOAT	2	Flow rate set-point for Pump A in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40015	14	R/W	FLOAT	2	Flow rate set-point for Pump B in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40017	16	R/W	FLOAT	2	Flow rate set-point for Pump C in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40019	18	R/W	FLOAT	2	Flow rate set-point for Pump D in Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40021	20	R/W	FLOAT	2	Flow rate set-point for multi-pump pair AB in Continuous Flow Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40023	22	R/W	FLOAT	2	Flow rate set-point for multi-pump pair CD in Continuous Flow Constant Flow mode.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40025	24	R/W	FLOAT	2	Refill flow rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40027	26	R/W	FLOAT	2	Refill flow rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40029	28	R/W	FLOAT	2	Refill flow rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40031	30	R/W	FLOAT	2	Refill flow rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40033	32	R/W	FLOAT	2	Maximum pressure set-point for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40035	34	R/W	FLOAT	2	Maximum pressure set-point for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40037	36	R/W	FLOAT	2	Maximum pressure set-point for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40039	38	R/W	FLOAT	2	Maximum pressure set-point for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40041	40	R/W	FLOAT	2	Minimum pressure set-point for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40043	42	R/W	FLOAT	2	Minimum pressure set-point for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40045	44	R/W	FLOAT	2	Minimum pressure set-point for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40047	46	R/W	FLOAT	2	Minimum pressure set-point for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40049	48	R/W	FLOAT	2	Maximum flow rate set-point for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40051	50	R/W	FLOAT	2	Maximum flow rate set-point for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40053	52	R/W	FLOAT	2	Maximum flow rate set-point for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40055	54	R/W	FLOAT	2	Maximum flow rate set-point for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40057	56	R/W	FLOAT	2	Minimum flow rate set-point for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40059	58	R/W	FLOAT	2	Minimum flow rate set-point for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40061	60	R/W	FLOAT	2	Minimum flow rate set-point for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40063	62	R/W	FLOAT	2	Minimum flow rate set-point for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40065	64	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40067	66	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40069	68	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.

Table 7-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40071	70	R/W	FLOAT	2	Maximum flow limit in Constant Pressure mode for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40073	72	R	FLOAT	2	Actual pressure of Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40075	74	R	FLOAT	2	Actual flow rate of Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40077	76	R	FLOAT	2	Volume remaining in Pump A.	milliliters
40079	78	R	FLOAT	2	Actual pressure of Pump B.	ATM; BAR; kPa; PSI See NOTE 1.
40081	80	R	FLOAT	2	Actual flow rate of Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40083	82	R	FLOAT	2	Volume remaining in Pump B.	milliliters
40085	84	R	FLOAT	2	Actual pressure of Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40087	86	R	FLOAT	2	Actual flow rate of Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40089	88	R	FLOAT	2	Volume remaining in Pump C.	milliliters
40091	90	R	FLOAT	2	Actual pressure of Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40093	92	R	FLOAT	2	Actual flow rate of Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40095	94	R	FLOAT	2	Volume remaining in Pump D.	milliliters
40097	96	R	FLOAT	2	System flow rate of multi-pump pair AB.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40099	98	R	FLOAT	2	System pressure of multi-pump pair AB.	ATM; BAR; kPa; PSI See NOTE 1.
40101	100	R	FLOAT	2	Total volume delivered by multi-pump pair AB.	Liters
40103	102	R	FLOAT	2	System flow rate of multi-pump pair CD.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40105	104	R	FLOAT	2	System pressure of multi-pump pair CD.	ATM; BAR; kPa; PSI See NOTE 1.
40107	106	R	FLOAT	2	Total volume delivered by multi-pump pair CD.	Liters
40109	108	R	FLOAT	2	Analog voltage input on Analog Input 1 of the accessory connector.	Volts
40111	110	R	FLOAT	2	Analog voltage input on Analog Input 2 of the accessory connector.	Volts
40113	112	R	FLOAT	2	Analog voltage input on Analog Input 3 of the accessory connector.	Volts
40115	114	R	FLOAT	2	Analog voltage input on Analog Input 4 of the accessory connector.	Volts
40117	116	R/W	FLOAT	2	Volume at which Pump A will automatically switch to refill mode if AUTO REFILL A is ON.	milliliters
40119	118	R/W	FLOAT	2	Volume at which Pump B will automatically switch to refill mode if AUTO REFILL B is ON.	milliliters
40121	120	R/W	FLOAT	2	Volume at which Pump C will automatically switch to refill mode if AUTO REFILL C is ON .	milliliters
40123	122	R/W	FLOAT	2	Volume at which Pump D will automatically switch to refill mode if AUTO REFILL D is ON.	milliliters
40125	124	R/W	FLOAT	2	Volume that Pump A will be refill to if AUTO FILL TO A is ON.	milliliters
40127	126	R/W	FLOAT	2	Volume that Pump B will be refill to if AUTO FILL TO B is ON.	milliliters

Table 7-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40129	128	R/W	FLOAT	2	Volume that Pump C will be refill to if AUTO FILL TO C is ON.	milliliters
40131	130	R/W	FLOAT	2	Volume that Pump D will be refill to if AUTO FILL TO D is ON.	milliliters
40133	132	R/W	FLOAT	2	Percentage of total pump volume that the refilling pump of multi-pump pair AB will refill to.	%
40135	134	R/W	FLOAT	2	Percentage of total pump volume that the delivering pump of multi-pump pair AB will deliver to.	%
40137	136	R/W	FLOAT	2	Percentage of total pump volume that the refilling pump of multi-pump pair CD will refill to.	%
40139	138	R/W	FLOAT	2	Percentage of total pump volume that the delivering pump of multi-pump pair CD will deliver to.	%
40141	140	R/W	FLOAT	2	POOR FILL MARK A	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40143	142	R/W	FLOAT	2	POOR FILL MARK B	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40145	144	R/W	FLOAT	2	POOR FILL MARK C	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40147	146	R/W	FLOAT	2	POOR FILL MARK D	% VALID ENTRYS:10,20,30,40,50,60,70,80,90
40149	148	R/W	FLOAT	2	Volume being dispensed by Pump A in Dispense mode.	milliliters
40151	150	R/W	FLOAT	2	Volume being dispensed by Pump B in Dispense mode.	milliliters
40153	152	R/W	FLOAT	2	Volume being dispensed by Pump C in Dispense mode.	milliliters
40155	154	R/W	FLOAT	2	Volume being dispensed by Pump D in Dispense mode.	milliliters
40157	156	R/W	FLOAT	2	Full scale input range voltage for External mode.	Volts
40159	168	R/W	FLOAT	2	MIN MOD PRESS: Minimum modifier pump pressure	ATM; BAR; kPa; PSI See NOTE 1.
40161	160	R/W	FLOAT	2	Value of %B for Modifier addition mode.%C for Continuous Modifier addition mode.	%B FOR MODIFIER OR %C FOR CONTINUOUS MODIFIER
40201	200	R	FLOAT	2	Absolute maximum pressure for Pump A.	ATM; BAR; kPa; PSI See NOTE 1.
40203	202	R	FLOAT	2	Absolute maximum flow rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40205	204	R	FLOAT	2	Absolute maximum refill rate for Pump A.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40207	206	R	FLOAT	2	Maximum volume for Pump A.	milliliters
40209	208	R	FLOAT	2	Absolute maximum pressure for Pump B.	ATM; BAR; kPa; PSI See NOTE 1.

Table 7-6 Holding Registers (Continued)						
Register	**Address**	**Read/ Write**	**Type**	**# of Registers**	**Description**	**Units**
40211	210	R	FLOAT	2	Absolute maximum flow rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40213	212	R	FLOAT	2	Absolute maximum refill rate for Pump B.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40215	214	R	FLOAT	2	Maximum volume for Pump B.	milliliters
40217	216	R	FLOAT	2	Absolute maximum pressure for Pump C.	ATM; BAR; kPa; PSI See NOTE 1.
40219	218	R	FLOAT	2	Absolute maximum flow rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40221	220	R	FLOAT	2	Absolute maximum refill rate for Pump C.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40223	222	R	FLOAT	2	Maximum volume for Pump C.	milliliters
40225	224	R	FLOAT	2	Absolute maximum pressure for Pump D.	ATM; BAR; kPa; PSI See NOTE 1.
40227	226	R	FLOAT	2	Absolute maximum flow rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40229	228	R	FLOAT	2	Absolute maximum refill rate for Pump D.	ml/min; ml/hr; ul/min; ul/hr See NOTE 2.
40231	230	R	FLOAT	2	Maximum volume for Pump D.	milliliters
40233	232	R	FLOAT	2	PUMP TYPE A	
40235	234	R	FLOAT	2	PUMP TYPE B	
40237	236	R	FLOAT	2	PUMP TYPE C	
40239	238	R	FLOAT	2	PUMP TYPE D	
40241	240	R	FLOAT	2	SOFTWARE MAJOR REV	
40243	242	R	FLOAT	2	SOFTWARE MINOR REV	
40245	244	R	FLOAT	2	SOFTWARE MICRO REV	

☑ ***Note***

Pressure and flow rate based on user selected units.

D Series Syringe Pumps

Section 8 Serial Interface

8.1 Overview

The Teledyne Isco D Series pump can be remotely controlled by a computer through a built-in RS-232-C serial or USB interface. This function is supported by the Teledyne Isco LabView™ toolkit.

You can write your own custom program to control Isco syringe pumps using any format, such as BASIC or C++. This section provides the syntax and responses for serial commands. Simplified examples of programs are also provided. It is possible for you to write custom programs capable of controlling up to 7 controllers from a single computer, each with up to 4 connected pumps. Writing programs for serial control requires substantial knowledge of the software language used, so Isco does not provide support for developing your own programs.

The toolkit is a sample program capable of running one controller and one to three pumps. Its primary purpose is to provide an example to help the programmer start constructing custom programs for individual pump systems and applications. To modify the program in any way, you must have the complete **LabView Compiler**, available from LabView's manufacturer:

National Instruments Corporation
www.ni.com
Tel: (800) 531-5066
Fax: 512-683-8411
11500 N. Mopac Expwy
Austin, TX 78759-3504

This section of the manual provides detailed information about:

Cable Connections for Serial Control

Setting up the Controller(s) for Serial Control

DASNET Protocol

Serial Commands

8.2 Network Control and Communication

Network communications are always initiated by the network controller, which is typically a computer. Messages from the instruments are in response to messages from the network controller. All information on the network is transmitted as groups of ASCII characters called frames. The message frames contain the origin of the message, the destination of the message, and a checksum to verify the validity of the message.

Each instrument is provided with a method of selecting unit identification numbers and a baud rate. For proper operation, each instrument must be set to a unique unit identification number (see Section). It is also important that each unit's baud rate is set to the same speed. Possible baud rates are **1200** and **19200**. Other baud rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 are supported by the D Series pumps but are not part of the Teledyne Isco defined communications standard.

Electrical standards are RS-232-C; connector pin usage is outlined in Table 8-1. Characters consist of 1 start bit, 8 data bits (low order first with 8^{th} bit always set to zero), and 1 stop bit. There is no parity bit used. All characters will be printable ASCII characters. Control characters (0-1FH) are ignored except for carriage return (0DH).

The serial unit number and baud rate can be changed from the default values through the MENU key. Select SERIAL under the menu; and adjust the values using the softkeys.

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Table 8-1 External control connector serial pin connections

Pin No.	Name	Use
1	CHASSIS GROUND	Used to connect to the shield of the interconnect cable.
2	RECEIVE	Serial interface data input. Standard RS-232-C signal levels.
3	TRANSMIT	Serial interface data output. Standard RS-232-C signal levels.
4	REQUEST TO SEND	RTS chain - RS-232-C input is buffered and connected to pin 21.
5	CLEAR TO SEND	CTS buffered RS-232-C output of pin 25 input.
6	+11 VDC	DATA SET READY is held on.
7	COMMON	Signal common for all signals.
8	+11 VDC	DATA CARRIER DETECT is held on.

9	+5 VDC	Test Voltage.
10	-11 VDC	Negative test voltage.
14	TRANSMIT CHAIN	Serial data from next unit.
16	RECEIVE CHAIN	Serial data to next unit.
21	RTS CHAIN	RTS buffered RS-232-C output of pin 4 input.
25	CTS CHAIN	CTS chain -RS-232-C input is buffered and connected to pin 5.
NOTE: Only pins 2, 3, & 7 are required for serial interface to one controller.		

8.3 USB Interface

The Isco D Series syringe pump controller may include an optional USB interface. The USB connections are located on the pump controller rear panel labeled USB/Ethernet. The connector pin usage is outlined in Table 8-2. Use optional cable (PN-60-1244-487) to connect the USB to the 25 pin connector labeled USB/Ethernet. The drivers for the USB can be downloaded from http://www.isco.com/support/updates.asp

⚠ WARNING

Connecting devices to energized circuits may cause personal injury or property damage. Power must be removed from the pump before connecting external devices.

Table 8-2 USB Interface Pin Connections

Pin Number	Name
7	GND
11	Data -
12	Data +

8.4 Cabling for Serial Control

The cabling scheme for your system will depend on the number of instruments you need to control. The computer is always connected from the serial port to the serial port(s) of the D Series controller(s) it is controlling. Each controller is connected to its pumps in the normal fashion, *i.e.* the pump control cables are attached to the pump A, B, and C connectors on the rear panel of the pump controller. The cable you select to connect to your network will depend on the type of serial port your computer has and the number of controllers you wish to connect.

Network communications are initiated by your computer.

8.4.1 One Controller

To connect one controller, use a null-modem cable (available from Teledyne Isco, part #480-7996-00) to connect the 9-pin serial output port of the computer to the RS-232-C port on the rear of the controller, as shown in Figure 8-1.

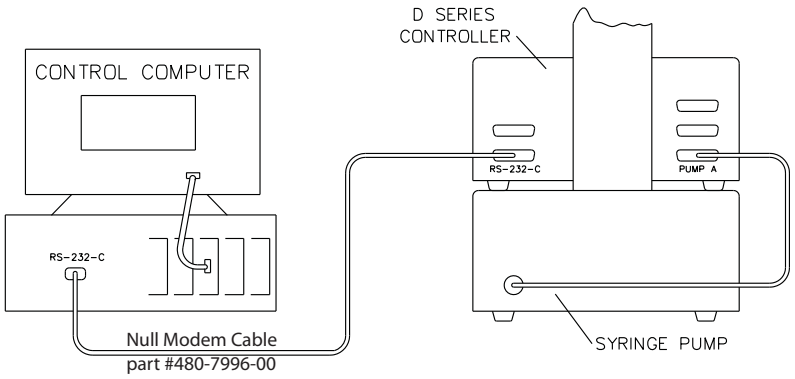


Figure 8-1 Serial network connection example - Single connection

With this configuration, your sample program is capable of:

- Constant flow
- Constant pressure
- Gradient

8.4.2 Two Controllers (Compiler required)

To connect two controllers in the network, use the 'Y' cable #68-1020-198, as shown in Figure 8-2.

> **Note**
>
> In order for the network to operate properly, all instruments connected to the network must be turned on even if they are not being used.

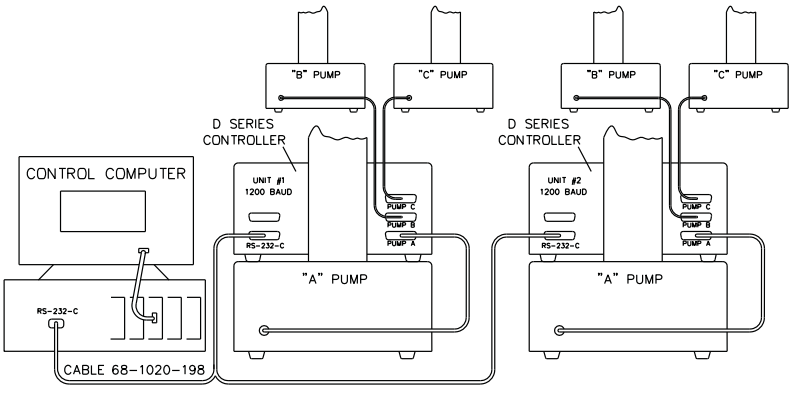


Figure 8-2 Serial network connection example - Dual connection

8.4.3 Three or More Controllers (Compiler required)

If additional instruments are to be connected in series, use the daisy chain cable, #68-1020-180. This cable is attached to the remaining connector on the 'Y' cable (Figure 8-2), and then to the RS-232-C connectors on the rear panels of the additional controllers.

8.5 Serial Control Check List

In order to build and operate a custom program for Isco syringe pumps, you must have the following:

1. Sample program (Isco LabView toolkit)*
2. LabView Compiler (purchased separately)
3. Connection cable(s)
4. 1 controller: cable 480-7996-00
5. 2 controllers: cable 68-1020-198
6. 3 to 7 controllers: cables 68-1020-198 and 68-1020-180.
7. Source code (serial commands in computer language for DASNET conversion)
8. DASNET serial driver

*The toolkit comes with directories for two different versions of LabView. Copy the .zip files onto your computer.

The files within each directory are as follows:

\labview8.5	**\labview5-8.2**
CONTROL.LLB	CONTROL.LLB
DASNET.DLL	DASNET.DLL
DATA.LLB	DATA.LLB
ISCO1.LLB	ISCO1.LLB
ISCO2.LLB	ISCO2.LLB
ISCO3.LLB	ISCO3.LLB
MULTPUMP.LLB	MULTPUMP.LLB
PANEL.VI	PANEL.VI
README.DOC	README.DOC
SERIALIO.LLB	SERIALIO.LLB

8.6 Controller Setup

Once the system is properly connected, turn the pump, controller(s), and computer on. Then use the following procedure to place your controller(s) in serial control mode.

Press MENU > MORE (A) and select SERIAL (1).
Factory controller default settings are baud rate 9600 and unit ID #6.

8.6.1 Restore Defaults (if desired)

To restore defaults, press MENU, then SYSTEM RESET (5). **Resetting a system erases all programs and user settings.**

8.6.2 Change Defaults

1. Press MENU > MORE (A) > 1. Serial Option to enter the serial option setup screen.
2. Select the communication baud rate (between 300 and 115.2K) by pressing NEXT BAUD (A) until you reach the desired baud rate.

> ☑ ***Note***
>
> All units in the network must be set to the SAME baud rate.

3. Select an identification number for each controller (up to seven) by pressing NEXT ID # (B) until you reach the desired number.

> **Note**
> Multiple controllers in a network must each have a different ID number.

If several units are being configured, place a label on the rear of each instrument listing the ID number and baud rate. This will help identify the controller in the future and prevent assigning the same ID number to two controllers or assigning an incorrect baud rate.

8.6.3 Verify Operation

To verify network operation, open a terminal emulator program on your computer, such as HyperTerminal, and establish connection with the controller.

> **Note**
> If you will be using multiple controllers daisy-chained to a single serial port, you must connect and test each controller one at a time.

1. Press MENU > MORE (A) > MORE (A), and select DIAGNOSTIC MENU (2).
2. Select SERIAL TEST (6).

The SENT value displayed will increment indefinitely until you exit the test by pressing any key. This same value should appear on your computer screen. If it does not, verify that you are using the correct serial port on the computer, and that the communication cables are properly connected and in working order.

8.7 User-written Software

When designing software to control the D Series pumps, you must follow the DASNET communications protocol. This protocol allows a number of instruments to be controlled from a single RS-232-C serial port. Up to seven D Series controllers may share a single serial data channel, with each controller only accepting commands that are meant for it. Each pump controller can then control up to four pumps each. Figure 8-1 shows a simple system where the PC is connected to the serial port on the rear panel of the pump controller (shown sitting on top of the pump module). The pump control cable is attached to the pump A connector on the rear panel of the controller.

8.7.1 DASNET

DASNET converts your direct serial commands into a form recognizable to our instruments. Using a computer language such as C or BASIC, serial commands can be entered, converted, and then sent to your instrument.

Table 8-3 is an example BASIC language program which performs the required portion of the DASNET serial protocol. Table 8-4 is an example of a C language program which does the same. Both of these programs, including a DASNET serial driver written in Visual C++, are available on CD-ROM (P/N ECR 60-1245-096) in the sleeve at the back of the printed manual.

For a console C++ example, refer to Table 8-4.

8.7.2 Universal Driver from Teledyne Isco

The Universal Driver from Teledyne Isco is a serial software driver that can translate commands for a variety of compilers. When you are creating programs for D Series syringe pumps, the driver converts serial commands to DASNET communications protocol, sends them to the serial port, and waits for a serial response.

> ☑ ***Note***
>
> On our website:
> Detailed information about the Universal Driver is provided in Isco Technical Bulletin TB19 Universal Driver Software Tool.
> LabView operation is discussed in detail in Isco Technical Bulletin TB06 Basic Operation of LabView Toolkit.

A copy of the driver can be found on the CD included in the back of your D Series pump user manual. It can also be downloaded from:

http://www.isco.com/products/appnotes.asp?PL=105.

Open the Software Utilities folder and select Universal D-Series Pump driver to download the utility to a zip folder. Extract the sub folder named "Remote Pump."

Table 8-3 Example of BASIC program to demonstrate conversion of pump commands to DASNET frames

```
1 CLS : Z$ = "": PRINT "INPUT ALL ENTRIES IN CAPITAL LETTERS"
5 INPUT "INPUT UNIT ID >> ", UNITNUM'GET UNIT NUMBER
30 REM OPEN COM PORT SET FOR COM2 EDIT TO COM1 IF NEED
40 OPEN "COM2:1200,N,8,1,ASC" FOR RANDOM AS #2
50 PRINT : INPUT "ENTER STRING (HIT Q TO EXIT) >> ", I$'GET OUTPUT STRING FROM USER
65 IF I$ = "" THEN GOTO 50                          'IF BLANK INPUT THEN GO BACK
70 IF I$ = "Q" THEN GOTO 200                        'IF "Q" INPUT THEN QUIT
80 GOSUB 10000                                      'CONVERT STRING TO DASNET FORMAT
90 GOSUB 20000                                      'OUT DASNET STRING TO COM 2
120 PRINT "DASNET FORMATTED CMD >> "; O$            'OUTPUT FORMATTED CMD TO USER
124 PRINT : PRINT ">>>> PRESS CTRL-C IF NO RESPONSE FROM PUMP <<<<"
125 LINE INPUT #2, Z$                               'GET RESPONSE FROM PUMP 'CR' ENDS STRING
127 PRINT "DASNET RESPONSE >> "; Z$                 'PRINT RESPONSE
128 Z$ = ""                                         'CLEAR BUFFER
130 GOTO 50                                         'GO BACK
200 CLOSE #2                                        'CLOSE COM2
210 SYSTEM                                          'END PROGRAM AND EXIT TO DOS

10000 REM this SUBROUTINE will convert a string (I$) into a string (O$)
10005 REM in DASNET protocol
10015 REM UNITNUM=UNIT NUMBER OF PUMP
10020 REM AFTER THE STRING IS SENT TO PUMP A CR IS REQUIRED TO TERMINATE MESSAGE
10030 REM VAR USED O$,I$,IL,Y$,LI,SUM,CSUM,UNITNUM
10100 O$ = CHR$(ASC("0") + UNITNUM)                 'PUT UNIT ID FIRST IN OUTPUT STRING
10110 IL = LEN(I$)                                  'GET LENGTH OF INPUT STRING
10115 REM IF INPUT IS JUST "R" ADD SPACE AND JMP BY # CHAR
10120 IF I$ = "R" THEN I$ = I$ + " ": GOTO 10180
10130 O$ = O$ + "R"                                 'ADD "R" TO OUTPUT STRING
10140 Y$ = HEX$(IL)                                 'GET # OF CHAR IN INPUT STRING IN HEX
10150 IF IL < 16 THEN Y$ = "00" + Y$                'PAD OUT # CHAR IN STRING IF NEED
10160 IF IL >= 16 THEN Y$ = "0" + Y$                'IF MORE THAN 16 THEN ONLY ONE PAD
10170 O$ = O$ + Y$                                  'ADD # CHAR TO OUTPUT STRING
10180 O$ = O$ + I$                                  'ADD INPUT STRING TO OUTPUT STRING
10190 IL = LEN(O$): SUM =                           'GET NEW LENGTH AND CLEAR SUM OUT
10200 FOR LI = 1 TO IL                              'TO ADD ALL ASCII FOR SUM
10210 SUM = SUM + ASC(MID$(O$, LI, 1))              'GET THE ASCII # OF (LI) ASCII CHAR
10220 NEXT LI
10230 REM THIS FINDS THE CHECKSUM
10235 REM THE # IS FIRST SUBTRACTED FROM 256
10236 REM THEN ANDED WITH 255 TO AND OFF EXTRA BITS
10240 CSUM = (256 - SUM) AND 255                    'GET CHECK SUM
10245 IF CSUM < 16 THEN O$ = O$ + "0"               'PAD OUT CSUM IF NEED
10250 O$ = O$ + HEX$(CSUM)                          'PUT AT END OF OUTPUT STRING
10270 RETURN                                        'DONE RETURN

20000 REM THIS SUBROUTINE SENDS O$ TO THE COM PORT
20010 PRINT #2,                                     'CR';     'SEND CR TO COM PORT
20020 PRINT #2, O$;                                 'SEND O$ TO COM PORT
20030 PRINT #2, 'CR';                               'SEND CR TO COM PORT
20040 RETURN                                        'DONE
```

Note: Polling is part of the DASNET definition but is not required and is not shown in this example. If this program is run on a PC as is, the commands entered at the keypad will be output on serial port 2. This code was written in QBasic, version 4.5. QBasic is an integrated BASIC language interpreter created by Microsoft Corp, Redmond, WA, included in MSDOS version 5.0 and later, and in Windows 95, 98, NT 3.x and NT4.

Table 8-4 Example of C program to demonstrate conversion of pump commands to DASNET frames

```
#include<stdio.h>
#include<conio.h>
#include "b:comm.c"                    /* edit to path needed */
                                       /* a 'C' example of DASNET serial control */
int conv_das();
unsigned char in[256],out[256],buf[256];
char unitnum;
main()
{
unsigned port;
int speed;
  cputs("ENTER UNIT ID=");             /* get parms */
  scanf("%d",&unitnum);
  cputs("ENTER COM PORT=");
  scanf("%d",&port);
  cputs("ENTER BAUD RATE=");
  scanf("%d",&speed);
  comm_open(port,speed);               /* open comm port */
  in[0]=50;
  cputs("ALL ENTRIES IN CAPS\n\r");
while(1)
  cputs("\n\rENTER STRING(Q TO QUIT) >>>");
  cgets(in);
  if(in[2]=='Q') break;
  conv_das(&in[2],out);                /* convert string */
  cputs("\nDASNET FORMATTED OUTPUT >>>");
  puts(out);                           /* output converted string */
  comm_putc(0x0d);                     /* send "CR" to serial port */
  dput(out);                           /* output converted string to serial port */
  comm_putc(0x0d);                     /* end with a "CR" */
  dgets(buf);                          /* get response */
  cputs("\nDASNET RESPONSE >>>");
  puts(buf);                           /* output response */
  comm_flush();                        /* flush serial buffer to start again */
  }
comm_close();
}
                                       /* dasnet conversion utility */
conv_das(char *in, char *out)
{
unsigned sum;
char *c_ptr;
c_ptr=out;                             /* point to output */
*out++=unitnum+0x30;                   /* put id first */
*out++='R';                            /* add "R" to output */
if (!strcmp(in,"R"))                   /* if just "R" add space to string */
  {
  *out++=' ';
  *out++=0x00;
  }
else                                    /* add # char to string */
  sprintf(out,"%3.3X%s",strlen(in),in);
for (sum=0 ; *c_ptr; c_ptr++)           /* add all chars together */
  sum+=*c_ptr;
sum=(0x100 - sum) & 0x0FF;             /* get check sum */
sprintf(c_ptr,"%2.2X",sum);            /* insert into string */
}
```

Note: Polling is part of the DASNET definition but is not required and is not shown in this example. This code was written in TurboC, version 4.5. TurboC is a compiler created by Borland Software Corp., Austin, TX. It is no longer actively sold by Borland International.

Table 8-5 Example of a Visual C++ program to demonstrate conversion of pump commands to DASNET frames

```
// visual C++ version 10.0
// Dasnet.cpp : Defines the entry point for the console application.
// A 'C, C++' example of DASNET serial control

#include "stdafx.h"
#include <windows.h>
#include<stdio.h>
#include<conio.h>
#include<string.h>

void commOpen(int port, long speed);
void conv_das(char *, char *);
void dgets(char *);
void dputs(char *);
void comm_putc(char);
int comm_getc(void);
BOOL GetCTS (void);


char unitnum;

HANDLE hCom;
DCB dcbSerialParams;

int _tmain(int argc, _TCHAR* argv[]) // console appication
{
      int commport;
      long speed;
      char in[512],out[512];

// printf("Starting Program");

printf("Enter Unit ID=");
scanf_s("%d",&unitnum);
printf("Enter Comm port=");
scanf_s("%d",&commport);
printf("Enter Baud Rate=");
scanf_s("%ld",&speed);
fflush(stdin);  //clear stdin buffer
commOpen(commport,speed);
while(1)
  {
  _cputs("\n\rString(Q TO Quit) >>>");
  gets_s(in,200);
  _strupr_s(in);  /*convert to upper case */
  if(in[0]=='Q') break;
  conv_das(in,out);
  _cputs("Dasnet Output >>>");
  puts(out);
  //printf("\nWriting to serial port");
  dputs(out);
  _strset_s(out,256,0);
  dgets(out);
  printf("Dasnet Response>>%s\n",out);
  }
```

Table 8-5 Example of a Visual C++ program to demonstrate conversion of pump commands to DASNET frames (Continued)

```
CloseHandle(hCom);
printf("Comm intr released\n");

}

void conv_das(char *in, char *out)
{
unsigned sum;
char *c_ptr;
c_ptr=out;
*out++=unitnum+0x30;  /* put id first */
*out++='R';

if (!strcmp(in,"R"))
  {
  *out++=' ';
  *out++=0x00;
  }

else
  sprintf_s(out,255,"%3.3X%s",strlen(in),in);

for (sum=0 ; *c_ptr; c_ptr++)
   sum+=*c_ptr;

sum=(0x100 - sum) & 0x0FF;        /* get check sum */
sprintf_s(c_ptr,255,"%2.2X",sum);
}

void dgets (char *buffer)
{
    char * ptr;
    DWORD dwBytesRead = 0;
    ptr = buffer;
    while (1)
    {
    char buf[2];
        /* get char if there                  */
    if(!ReadFile(hCom, buf, 1, &dwBytesRead, NULL))
            {
            //error occurred. Report to user.
            }
      *buffer=buf[0];
      if (*buffer++ == 0x0d && ptr!=buffer || dwBytesRead==0)
       {
       *buffer = 0;
       break;
       }

    }
}
void dputs(char *out)
{
int n;
DWORD dwBytesRead = 0;
```

Table 8-5 Example of a Visual C++ program to demonstrate conversion of pump commands to DASNET frames (Continued)

```
int count=0;

n=strlen(out);
// start of packet
if(!WriteFile(hCom, "\r", 1, &dwBytesRead, NULL))
                {
                //error occurred. Report to user.
               }
// data
if(!WriteFile(hCom, out, n, &dwBytesRead, NULL))
                {
                //error occurred. Report to user.
                }
//end of packet
if(!WriteFile(hCom, "\r", 1, &dwBytesRead, NULL))
                {
                //error occurred. Report to user.
                }
}

void commOpen(int port, long speed)
{
TCHAR szComPort[20];

      if (port < 10)
        wsprintf(szComPort, _T("COM%d"), port);
      else
        wsprintf(szComPort, _T("\\\\.\\COM%d"),port);

       hCom = CreateFile(szComPort,
            GENERIC_READ|GENERIC_WRITE, // desired access should be read&write
            0,                    // COM port must be opened in non-sharing mode
            NULL,                 // don't care about the security
            OPEN_EXISTING,        // IMPORTANT: must use OPEN_EXISTING for a COM port
            0,                    // usually overlapped but non-overlapped for existance test
            NULL);                // always NULL for a general purpose COM port

      if (INVALID_HANDLE_VALUE == hCom)
        {
            printf("\nComm %d port not available",port);
            //Sleep(2000);
            //exit(1);
            Sleep(1000);
            return;
        }
      else
      {
          printf("\nComm %d port available ",port);
          dcbSerialParams.DCBlength=sizeof(dcbSerialParams);

          if (!GetCommState(hCom, &dcbSerialParams))
                {
                //error getting state
                printf("Error getting Comm Port state");
```

Table 8-5 Example of a Visual C++ program to demonstrate conversion of pump commands to DASNET frames (Continued)

```
            Sleep(2000);
            exit(1);
              }
        switch(speed)
              {
              case 19200:
                    dcbSerialParams.BaudRate=CBR_19200;
                    break;
              case 38400:
                    dcbSerialParams.BaudRate=CBR_38400;
                    break;
              case 57600:
                    dcbSerialParams.BaudRate=CBR_57600;
                    break;
               case 115200:
                    dcbSerialParams.BaudRate=CBR_115200;
                    break;
            default:
              case 9600:
                    dcbSerialParams.BaudRate=CBR_9600;
                    break;
            }
        dcbSerialParams.ByteSize=8;
        dcbSerialParams.StopBits=ONESTOPBIT;
        dcbSerialParams.Parity=NOPARITY;
        if(!SetCommState(hCom, &dcbSerialParams))
              {
              //error setting serial port state
              printf("Setting Comm port state failed");
            Sleep(2000);
            exit(1);
              }
        //timeouts
        COMMTIMEOUTS timeouts={0};
        timeouts.ReadIntervalTimeout=100;
        timeouts.ReadTotalTimeoutConstant=100;
        timeouts.ReadTotalTimeoutMultiplier=100;
        //timeouts.WriteTotalTimeoutConstant=50;
        //timeouts.WriteTotalTimeoutMultiplier=10;
        if(!SetCommTimeouts(hCom, &timeouts))
              {
              //error occureed. Inform user
              printf("Setting Comm port timeouts failed");
              Sleep(2000);
              exit(1);
              }
        }
printf("\nComm intr installed");
}

int comm_getc ()
{
DWORD dwBytesRead = 0;
```

Table 8-5 Example of a Visual C++ program to demonstrate conversion of pump commands to DASNET frames (Continued)

```
char buf[2];
buf[0]=0;
        /* get char if there                */
   if(!ReadFile(hCom, buf, 1, &dwBytesRead, NULL))
            {
            //error occurred. Report to user.
            }
     return buf[0];
}
void comm_putc(char outchar)
{
DWORD dwBytesRead = 0;
char out[2];
out[0]=outchar;

if(!WriteFile(hCom, out, 1, &dwBytesRead, NULL))
                {
                //error occurred. Report to user.
                }

}
```

There are three types of operation within the network: network controller, master, and slave. A computer typically serves as the network controller. It supervises all data flow on the network. It also polls each unit which initiates data transfer and commands.

> **Note**
>
> The network controller (typically a PC) should not be confused with the pump controller. The network controller is used in addition to the pump controller.

The slave unit simply responds to commands accordingly. The D Series pump functions as a slave unit. These functions may be combined in one unit; *i.e.*, a computer can function as both a network controller and a master.

All data transfers are in a frame format. When the network controller polls an instrument, it will start to respond within 200 ms. If it does not reply, it will be polled again. If after three attempts at polling it does not reply, it will be dropped from the polling rotation. When the instrument does respond, the polling rotation does not advance until an error-free transfer has occurred.

The frame format for data transfers from the network controller is as follows:

destination\acknowledgement\message source \length\message\checksum\[CR]

- The **destination** is the 1-digit unit identification number of the instrument to receive the message.

- **Acknowledgment** is one character to indicate the success of the previous transmission. There are three possibilities: (1) E means error, resend the message immediately (E is sent by the network controller only. Other units signify errors by not replying; causing the controller to resend the message). (2) B means busy, resend message at next poll. (3) R signifies previous message was received.
- **Message source** is the unit ID of the unit that originated the message. If there is no message, this location is a space (20H).
- **Length** is the length of the message in 2 digit, hexadecimal format. Maximum length is 256, with 256 being represented by a 00. This field is eliminated if there are no messages.
- **Message field** is the area where the actual information is located. The maximum length is 256 characters long.
- **Checksum** is also a 2 digit hexadecimal number. This number, when added to all the previous characters in the message (excluding control characters), will result in a sum. If there are no errors, the result of modulo 256 division of this sum should be 0.

Examples

Frame is R304STOPD1[CR] =

(R) (3) (0) (4) (S) (T) (O) (P)
52H + 33H + 30H + 34H + 53H + 54H + 4FH + 50H + D1H = 300H

300H MODULO 256 = 00

It is important to note that all characters are converted to the ASCII equivalent and added, except for the checksum. The two characters of the checksum are converted to hexadecimal numbers and concatenated to form a single two-digit number. This number is then converted to its ASCII equivalent and added to the end of the message.

Hexadecimal Format Using MODULO

Step 1: **22FH = 52H + 33H + 30H + 34H + 53H + 54H +4FH + 50H**

Step 2: **2FH = 22FH ∕ 100H** (Modulo)

$$100H \overline{)\ 22FH}\ \ 2R2FH$$
$$-200H$$
$$2FH$$

Step 3: **D1H = 100H − 2FH**

Step 4: Convert D1H to ASCII (Hex) and put at end of message.

Step 5: Put a “CR” (0DH) at the end of message for end of frame.

Decimal Format Using MODULO

Step 1: **559 = 82 + 51 + 48 + 52 + 83 + 84 + 79 + 80**

Step 2: **47 = 559 ⁄ 256**

Modulo

```
        2R47
    ┌──────
256 │ 559
    −512
    ────
      47
```

Step 3: **209 = 256 − 47**

Step 4: Convert 209 to ASCII (Hex) and put at end of message.

Step 5: Put a "CR" (13) at the end of message for end of frame.

Hexadecimal Format Using NO MODULO

Step 1: **22FH = 52H + 33H + 30H + 34H + 53H + 54H + 4FH + 50H**

Step 2: **FED1H = 100H − 22FH**

Step 3: **D1H = FED1H & offH**

Step 4: Convert D1H = to ASCII (Hex) and put at end of message.

Step 5: Put a "CR" (0DH) at the end of message for end of frame.

Decimal Format Using NO MODULO

Step 1: **559 = 82 + 51 + 48 + 52 + 83 + 84 + 79 + 80**

Step 2: **−303 = 256 − 559**

Step 3: **209 = 303 & 255**

Step 4: Convert 209 into ASCII (Hex) and put at end of message.

Step 5: Put a "CR" (13) at the end of message for end of frame.

The carriage return "CR" signifies end of frame.

The format for frames sent from the unit to the network controller is as follows:

acknowledgement\message destination \length\message\checksum\[CR]

All the parameters are as previously described except message destination. Message destination is the 1-digit identification number of the unit that the message is sent to.

An example of a typical data exchange is summarized below. For illustration, we will assume the network consists of a computer serving as a combination network controller and master. There will be one slave unit; a Model 260D pump. Details on the pump message format are in section 8.8. The computer will be unit #0, and the pump will be unit #6.

Network Controller and Master Unit #0

[CR]1R 5D[CR]

> **Note**
>
> A [CR] must start the network. The controller is checking for the presence of unit #1 but will get no response in 200 ms because there is no unit 1.

Network Controller and Master Unit #0

1R 5D[CR]
Still no response.

Network Controller and Master Unit #0

1R 5D[CR]
Still no response, so unit 1 will be dropped from the poll.

Network Controller and Master Unit #0

2R 5C[CR]
Checks for unit 2 but will get no response in 200 ms because there is no unit 2.

Network Controller and Master Unit #0

2R 5C[CR]
Still no response.

Network Controller and Master Unit #0

2R 5C[CR]
Still no response, so unit 2 will be dropped from the poll.

In this way units 3-5 will be checked and dropped from the poll.

Network Controller and Master Unit #0

6R 58[CR]
Check for presence of unit 6.

Unit 6

R 8E[CR]
Unit 6 responds.

Network Controller and Master Unit #0

7R 57[CR]
Since unit 7 does not exist, it will be dropped from the polling scheme.

Network Controller and Master Unit #0

6R008IDENTIFY84[CR]
The master verifies the fact that unit 6 is a Model ___D. In

this example, the master and the network controller are a single unit. If they were separate units, the master would send the inquiry to the network controller; then the network controller would send the message to the slave unit the next time it is polled. The slave would respond with the message to the network controller. The next time the master is polled, the message would be relayed. The same sequence would occur with all messages. Since the master and the network controller are combined in this example, the relaying of messages is not necessary.

Unit 6

R027SERIES=1240-02__, Model ___D PUMP, REV __XX[CR]
The pump responds with identity and software revision letter. (In this example 02__ would be 021; Model ___D would be 260D; REV __ signifies the software revision, XX would be replaced by the correct checksum, which is B4.)

Network Controller and Master Unit #1

6R006REMOTE16[CR]
This places the pump in the remote mode.

Unit 6

R 8E[CR]
The pump acknowledges that it accepted the command.

Network Controller and Master Unit #1

6R00ACONST FLOWF8[CR]
This puts the pump into constant flow rate mode.

Unit 6

R 8E[CR]
The pump verifies that it received the message.

Network Controller and Master Unit #1

6R009FLOW=1.00AB[CR]
This sets the pump's flow rate to 1.00 ml per minute.

Unit 6

R 8E[CR]
The pump verifies that it received the message.

Network Controller and Master Unit #1

6R 58[CR]
Polls the pump.

Unit 1

R 8E[CR]
Pump responds.

Network Controller and Master Unit #1

6R003RUNF0[CR]
The pump is started.

Unit 1

R 8E[CR]
The pump responds.

The system is now running and the network controller continues the polling scheme. If the controller gives an improper command, the units will respond with a problem message indicating the type of error.

The format of the message is given in section 8.8 of this manual and specifies the commands used for this instrument. It is important to follow this format. Spaces are ignored anywhere within the message field. Commands must be in uppercase letters. The network definition allows multiple commands in a message field when delimited by semicolons, but the D Series controller is limited to single commands. It will respond with a PROBLEM=INVALID COMMAND message.

8.8 Serial Commands for the D Series Pump

Table 8-6 is a list of the serial commands recognized by the pump. These commands are the message part of the DASNET protocol. The operand always follows the equals sign. The REMOTE command must be sent once, before any command that changes the operation of the pump will be accepted.

> ☑ ***Note***
>
> When setting a value, the serial command will always be followed by an equal sign.

Table 8-6 Serial Commands

Command	Description
%B=#	Enter # for percentage of modifier.
ALOG1	Status of the analog voltage input on pin 21, P6. See NOTE 1.
ALOG2	Status of the analog voltage input on analog input 3 of the accessory connector. See NOTE 1.
ALOG3	Status of the analog voltage input on analog input 2 of the accessory connector. See NOTE 1.
ALOG4	Status of the analog voltage on analog input 1 of the accessory connector. See NOTE 1.
ALOG5	Status of the analog voltage input for Press D. See NOTE 1.
ALOG6	Status of the analog voltage on analog input 4 of the accessory connector. See NOTE 1.
CLEAR	Stops all motors, sets flow rate and pressure setpoints to zero.
CONTIN CONST FLOW CONTIN CONST FLOWCD	Puts pump in continuous flow under constant flow mode.
CONTIN CONST PRESS CONTIN CONST PRESSCD	Puts pump in continuous flow under constant pressure mode.
CONTIN MODIFIER	Put pump in continuous modifier addition mode.
CONST FLOW CONST FLOWB CONST FLOWC CONST FLOWD	Put pump in constant flow mode.
CONST PRESS CONST PRESSB CONST PRESSC CONST PRESSD	Put pump in constant pressure mode.
DELIVER DELIVERCD	Set the dual pump mode to deliver fluid when running.
DIGITAL	Returns the status (High or Low) of the digital outputs. Format is digital = xxxxxxxx, where “x” is either “H” or “L”. The status order returned corresponds with the outputs 1—8. “X”= no change.
DIGITAL = xxxxxxxx 1——— 8	Sets the digital output either High or Low, where “x” is either “H” or “L”. The order corresponds with the outputs 1—8.

Table 8-6 Serial Commands (Continued)

Command	Description
DIG CONTROL	Returns the status of the digital output control bits as either REMOTE (R) or INTERNAL (I). The return message format is DIG CONTROL=xxxxxx, where "x" is either "R" or "I". "R" indicates the corresponding bit is controlled remotely; and "I" indicates the corresponding bit is controlled internally by pump software. The status order returned corresponds with the outputs 1—8.
DIG CONTROL = command 1 ——— 8	Sets the digital output control bits to either internal or remote, where "x" is either "R" for REMOTE or "I" for INTERNAL CONTROL. "R" indicates the corresponding bit will be controlled remotely (through the serial port). "I" indicates the corresponding bit will be controlled internally by pump software. The order corresponds with the outputs 1—8.
DISPENSEA DISPENSEB DISPENSEC DISPENSED	Returns the dispense volume for Dispense mode.
DISPENSEA=# DISPENSEB=# DISPENSEC=# DISPENSED=#	Sets the dispense volume for Dispense mode. Format is XXX.XXX ml. Leading and trailing zeros are not required. Can only be changed when pump is stopped.
FLOW FLOWCD	Returns the delivering pump's flow rate in continuous pumping mode and modifier addition mode. In INDEPENDENT mode FLOW returns the pump A flow rate and FLOWCD returns the pump C flow rate.
FLOWA FLOWB FLOWC FLOWD	Returns the actual flow rate of the pump.
FLOW=# FLOWB=# FLOWC=# FLOWD=#	Returns the actual flow rate of the pump Enter # for a flow rate setpoint (constant flow mode). Format is XXX.XXXXXXX ml/min. Only 5 figures are significant. Leading and trailing zeros are not required.
G GG G& G&2	Gets pump information. "G" returns a text string that contains current pressure, analog input, and digital input information. "G&" is the Get All command. This returns the same information as "G," plus flow rates, units, operation status, and more. For four pump operation ise the G&2 commands. Refer to 8.8.1 for a complete description of this serial command.
IDENTIFY	Pump responds "SERIES=1240-0___, MODEL ____D PUMP; REV__." For each pump, REV__ is the internal pump program software revision. (For example, if the controller was attached to two 100DMs, the message would read "SERIES=1240-024, MODEL 100DM PUMP; SERIES=1240-024, MODEL 100DM; REV__.") The series number is the original catalog number for the pump type. It may not match the production series number on the pump serial label. SERIES=1240-024, MODEL 100DM PUMP SERIES=1240-027, MODEL 100DX PUMP SERIES=1240-021, MODEL 260D PUMP SERIES=1240-025, MODEL 500D PUMP SERIES=1240-103, MODEL 500HPx PUMP SERIES=1240-052, MODEL 1000D PUMP SERIES=1240-063, MODEL 65D PUMP SERIES=1240-096, MODEL 65DM PUMP SERIES=1240-819, MODEL 30D PUMP

Table 8-6 Serial Commands (Continued)

Command	Description
INDEPENDENT INDEPENDENTCD	Put pumps in Independent mode.
IPUMPA=1, IPUMPA=0 IPUMPB=1, IPUMPB=0 IPUMPC=1, IPUMPC=0 IPUMPD=1, IPUMPD=0	Turns the pressure integral control On and Off for the pump indicated. 1 = ON 0 = OFF
LGE,F:XX,A:0X	Action to perform when gradient program reaches the end. The pump needs to be in local mode only. File # F: 01-99 Action A: 00=Hold final value 01=Stop after final step 02=Return to initial value and hold 03=Return to initial value and repeat program
LGGO	Start Gradient Command. This starts a gradient program (same as the “RUN” key). This command will check to see if there is a gradient running and respond with “RUNNING” if there is. The pump needs to be in local mode only.
LGSL,F:xx	Select Gradient File Command. This selects a gradient file to be run. This command will reset the controller to the saved file gradient type. If the selected gradient file does not exist, the controller will respond with “PROBLEM=INVALID OPERAND.” The pump needs to be in local mode only.
LGST	Stop Gradient Command. This stops a gradient program. The pump needs to be in local mode only.
LGDL,F:xx,S:xx	Gradient Step Download command. This downloads a step from the pump to the PC. This command will respond with “PROBLEM=INVALID OPERAND” if the file or step does not exist. The controller will respond with step information if the command is valid. Refer to 8.8.2 for complete information on Gradient step download commands. The pump needs to be in local mode only.
LGUL,F:xx,S:xx	Gradient Step Upload command. This transfers a step from the PC to the controller. Refer to 8.8.3 for complete information on Gradient step download commands. The pump needs to be in local mode only.
LIMITS LIMITSB LIMITSC LIMITSD	Returns the pressure and flow rate limits.
LOCAL	Returns the instrument to local control. Front panel control is enabled and all motors are stopped (if control was previously remote).
MAXFLOWA=# MAXFLOWB=# MAXFLOWC=# MAXFLOWD=#	Enter # to designate the maximum flow rate setpoint.
MAXFLOWA MAXFLOWB MAXFLOWC MAXFLOWD	Returns the maximum flow rate setpoint.
MAXPRESSA=# MAXPRESSB=# MAXPRESSC=# MAXPRESSD=#	Enter # to designate the maximum pressure setpoint.

Table 8-6 Serial Commands (Continued)

Command	Description
MAXPRESSA MAXPRESSB MAXPRESSC MAXPRESSD	Returns the maximum pressure setpoint.
MFLOWA=# MFLOWB=# MFLOWC=# MFLOWD=#	Enter # to designate the maximum flow limit in constant pressure mode.
MFLOWA MFLOWB MFLOWC MFLOWD	Returns the maximum flow limit setpoint.
MINFLOWA=# MINFLOWB=# MINFLOWC=# MINFLOWD=#	Enter # to designate the minimum flow rate setpoint.
MINFLOWA MINFLOWB MINFLOWC MINFLOWD	Returns the minimum flow rate setpoint.
MINPRESSA=# MINPRESSB=# MINPRESSC=# MINPRESSD=#	Returns the minimum pressure setpoint.
MINPRESSA MINPRESSB MINPRESSC MINPRESSD	Returns the minimum pressure setpoint.
MODE	MODE A P, B P, C P, D-P A, B, C, D refer to the pump connection. P- Constance Pressure F- Constant Flow R- Refill PG- Pressure Gradient F1- Flow Gradient 1 Pump F2- Concentrated Gradient 2 Pump CF- Continuous Constant Flow CP- Continuous Constant Pressure MO- Modifier Mode 2 Pump MM- Modifier Mode 3 Pump
MODIFIER	Put pumps in modifier addition mode.
PRESS=# PRESSB=# PRESSC=# PRESSD=#	Enter # to designate pressure setpoint (constant pressure mode).
PRESS PRESSCD	Returns the delivering pump pressure in continuous pumping mode and modifier addition mode. In INDEPENDENT mode PRESS returns the pump A pressure and PRESSCD returns the pump C pressure.
PRESSA PRESSB PRESSC PRESSD	Returns the actual pressure of the pump.

Table 8-6 Serial Commands (Continued)

Command	Description
PRESSCNTRLDIFF1	Sets the pressure control input to Analog input 1, with a pressure range of 50 psi.
PRESSCNTRLDIFF1=XXXXX	Sets the pressure control input to Analog input 1 and sets the pressure range. The range is 1 to 5000. the units are psi, with a value of 5000 representing 5000 psi at 5 volts.
PRESSCNTRLDIFF2	Sets the pressure control input to Analog input 2, with a pressure range of 500 psi at 5 volts.
PRESSCNTRLDIFF3	Sets the pressure control input to Analog input 2, with a pressure range of 5000 psi at 5 volts.
PRESSCNTRLNORM	Sets the pressure control input to the standard input.
PRESSDIFF=XXXXX	Differential pressure setpoint. (PSI*10) 0 to 50,000 maximum (0 to 5000 psi)
PRESSDIFF	Reads the differential pressure value. (PSI*10) The transducer can also be read via the “ALOGx” serial commands.
RANGEA RANGEB RANGEC RANGED	Provides scaling information for the system parameters. See 8.8.4 for more information about this serial command.
RAPIDA RAPIDB RAPIDC RAPIDD	Activates the automatic rapid pressurization cycle (constant flow mode only).
RECEIVE RECEIVECD	Set the dual pump mode to receive fluid when running.
REFILL REFILLB REFILLC REFILLD	Move cylinder to bottom at preset refill rate.
REFILL=# REFILLB=# REFILLC=# REFILLD=#	Enter # to designate refill rate.
REMOTE	Disables controller front panel control and enables all serial commands. Stops all motors (if control was previously local).
RLIMITA RLIMITB RLIMITC RLIMITD	Returns the refill flow rate limit.
RSVP RSVPB RSVPC RSVPD	Pump responds with “READY” message.
RUN RUNB RUNC RUND RUNALL	Same as front panel. Initiates pumping.
SETFLOWA SETFLOWB SETFLOWC SETFLOWD	Returns the flow rate setpoint.

Table 8-6 Serial Commands (Continued)

Command	Description
SETPRESSA SETPRESSB SETPRESSC SETPRESSD	Returns the pressure setpoint.
STATUSA STATUSB STATUSC STATUSD	Returns with status of pump. May be any combination of responses listed below. **STATUS=** STOP, RUN, REFILL, HOLD, EQUIL., LOCAL, REMOTE, EXTERNAL **PROBLEM=** OVER PRESSURE, UNDER PRESSURE, CYLINDER FULL, CYLINDER EMPTY, MOTOR FAILURE
STOP STOPB STOPC STOPD STOPALL	Same as front panel, except that pump remains under remote serial control.
UNITSA=	Enter the desired flow or pressure units after the equal sign. Acceptable values are: ATM, BAR, KPA, PSI, ML/MIN, ML/HR, UL/MIN, UL/HR. (Sets all pumps.)
VOLA VOLB VOLC VOLD	Return the volume remaining in cylinder in ml. Format is “XXX.XXXX” ml.
VOLTOT VOLTOTCD	Returns the total volume delivered when using continuous flow or modifier.
VOL RESET VOL RESETCD	Will reset the volume total to zero.
ZEROA ZEROB ZEROC ZEROD	“Zeros” the pressure sensor offset.
ZERODIFF1 ZERODIFF2 ZERODIFF3	“Zeros” the pressure sensor offset for the respective analog input.
NOTE 1: The analog input range is -1.5 to 11.6 volts. There is NO conversion of the returned number. The number returned (0 to 65535 decimal) will have an offset of 7500 added to the number (7500 = 0 volts) and a scale of 5000 for every 1 volt, for example: $\frac{\text{number} - 7500}{5000} = \text{volts}$ $\frac{(32500 - 7500)}{5000} = 5 \text{ volts}$	
NOTE 2: The only pump B commands accepted in continuous pumping mode or modifier addition mode are: %B, FLOWB, LIMITSB, PRESSB, REFILLB, REFILLB=, STATUSB, VOLB.	

8.8.1 Get Status Command

The “G” and “G&” serial commands retrieve information from the pump controller. Each command returns a text string which can be read as shown in Figures 8-3 and 8-5.

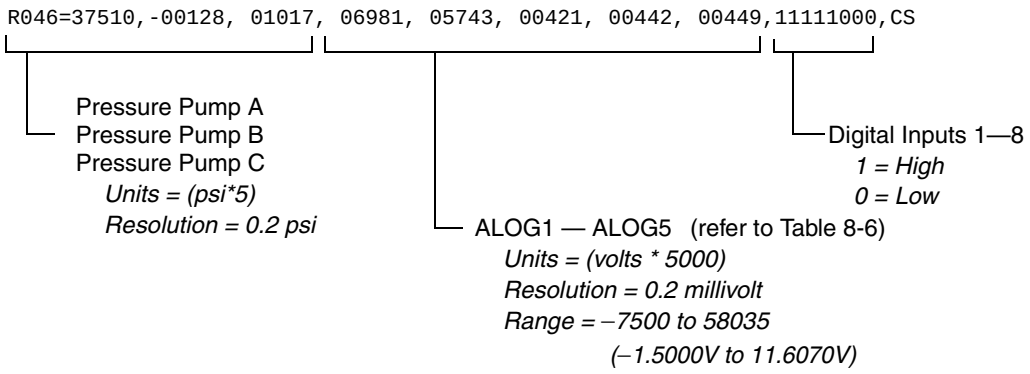

R046=37510,-00128, 01017, 06981, 05743, 00421, 00442, 00449,11111000,CS
Pressure Pump A
Pressure Pump B
Pressure Pump C
Units = (psi*5)
Resolution = 0.2 psi
ALOG1 — ALOG5 (refer to Table 8-6)
Units = (volts * 5000)
Resolution = 0.2 millivolt
Range = −7500 to 58035
(−1.5000V to 11.6070V)
Digital Inputs 1—8
1 = High
0 = Low

Figure 8-3 Get Status String "G" Command

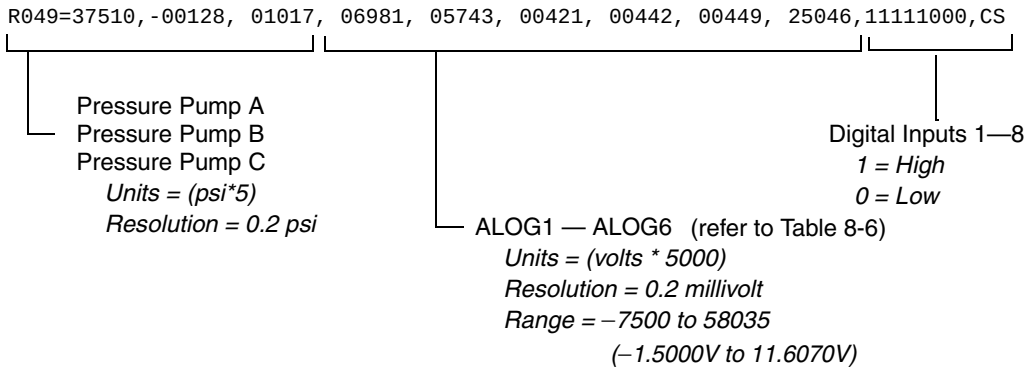

R049=37510,-00128, 01017, 06981, 05743, 00421, 00442, 00449, 25046,11111000,CS
Pressure Pump A
Pressure Pump B
Pressure Pump C
Units = (psi*5)
Resolution = 0.2 psi
ALOG1 — ALOG6 (refer to Table 8-6)
Units = (volts * 5000)
Resolution = 0.2 millivolt
Range = −7500 to 58035
(−1.5000V to 11.6070V)
Digital Inputs 1—8
1 = High
0 = Low

Figure 8-4 Get Status String "GG" Command

Figure 8-5 Get All Status String "G&" Command

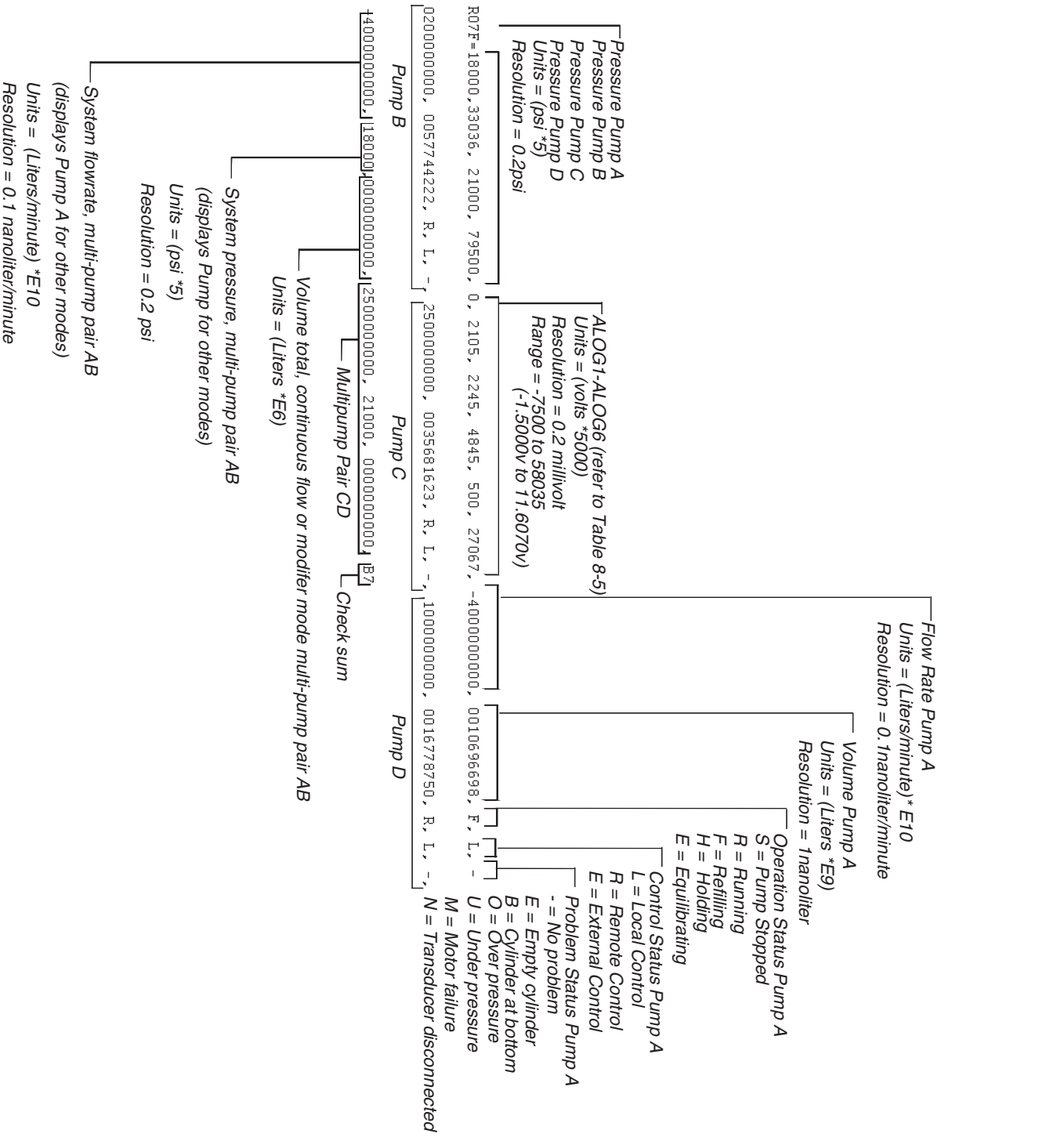

Flow Rate Pump A
Units = (Liters/minute)* E10
Resolution = 0.1nanoliter/minute
Volume Pump A
Units = (Liters *E9)
Resolution = 1nanoliter
Operation Status Pump A
S = Pump Stopped
R = Running
F = Refilling
H = Holding
E = Equilibrating
Control Status Pump A
L = Local Control
R = Remote Control
E = External Control
Problem Status Pump A
- = No problem
E = Empty cylinder
B = Cylinder at bottom
O = Over pressure
U = Under pressure
M = Motor failure
N = Transducer disconnected
Pump D
1000000000, 001677875O, R, L, -,
Pump C
2500000000, 0035681623, R, L, -,
-4000000000, 0010696698, F, L, -
ALOG1-ALOG6 (refer to Table 8-5)
Units = (volts *5000)
Resolution = 0.2 millivolt
Range = -7500 to 58035
(-1.5000v to 11.6070v)
Pressure Pump A
Pressure Pump B
Pressure Pump C
Pressure Pump D
Units = (psi *5)
Resolution = 0.2psi
R07F=18000,33036, 21000, 79500, 0, 2105, 2245, 4845, 500, 27067,
Pump B
0200000000, 0057744222, R, L, -,
Multipump Pair CD
2500000000, 21000, 0000000000, E7
Check sum
Volume total, continuous flow or modifer mode multi-pump pair AB
Units = (Liters *E6)
System pressure, multi-pump pair AB
(displays Pump for other modes)
Units = (psi *5)
Resolution = 0.2 psi
+4000000000, 18000, 0000000000,
System flowrate, multi-pump pair AB
(displays Pump A for other modes)
Units = (Liters/minute) *E10
Resolution = 0.1 nanoliter/minute

Figure 8-6 Get all status strings from four pump operation "G&2" Command

8.8.2 Gradient Download Command

This command downloads a step from the D Series pump to the PC. This command will respond with "PROBLEM=INVALID COMMAND" if the file or step does not exist. If the file and step is valid, the controller will respond as shown in Figures 8-7 and 8-8.

8.8.3 Gradient Upload Commands

These commands upload a step from the PC to the D Series pump. This command will respond with "PROBLEM=INVALID COMMAND" if the file or step does not exist. If the file and step is valid, the controller will respond as shown in Figures 8-9 and 8-10. Figure 8-11 shows an example of a pressure programming upload command.

> **Note**
>
> Gradient upload commands must follow the format shown in the figures below. Where necessary, leading and trailing zeros must be included so that the numerical values are represented properly. Also note that the single-pump gradient commands include spaces in the command string.

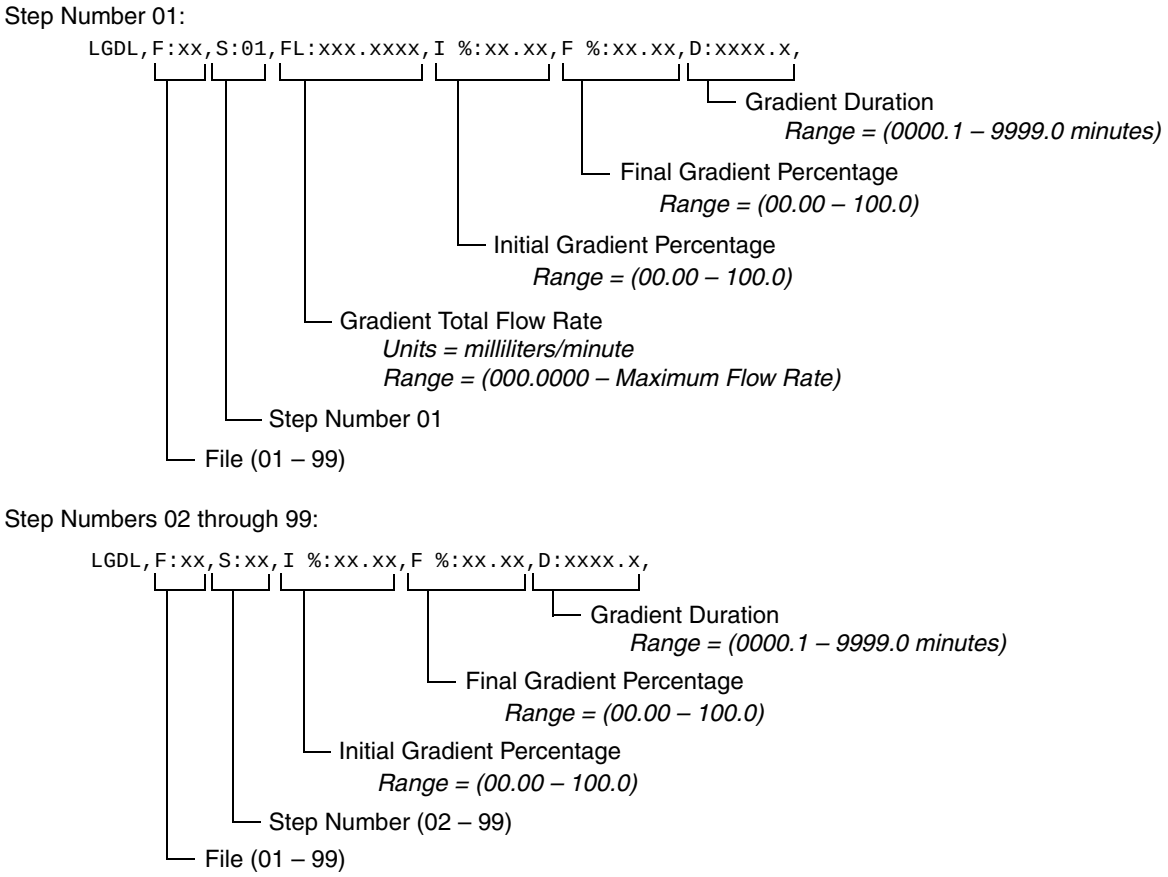

Step Number 01:
LGDL,F:xx,S:01,FL:xxx.xxxx,I %:xx.xx,F %:xx.xx,D:xxxx.x,
Gradient Duration
Range = (0000.1 – 9999.0 minutes)
Final Gradient Percentage
Range = (00.00 – 100.0)
Initial Gradient Percentage
Range = (00.00 – 100.0)
Gradient Total Flow Rate
Units = milliliters/minute
Range = (000.0000 – Maximum Flow Rate)
Step Number 01
File (01 – 99)
Step Numbers 02 through 99:
LGDL,F:xx,S:xx,I %:xx.xx,F %:xx.xx,D:xxxx.x,
Gradient Duration
Range = (0000.1 – 9999.0 minutes)
Final Gradient Percentage
Range = (00.00 – 100.0)
Initial Gradient Percentage
Range = (00.00 – 100.0)
Step Number (02 – 99)
File (01 – 99)

Figure 8-7 Gradient Download Commands - Single pump flow gradient

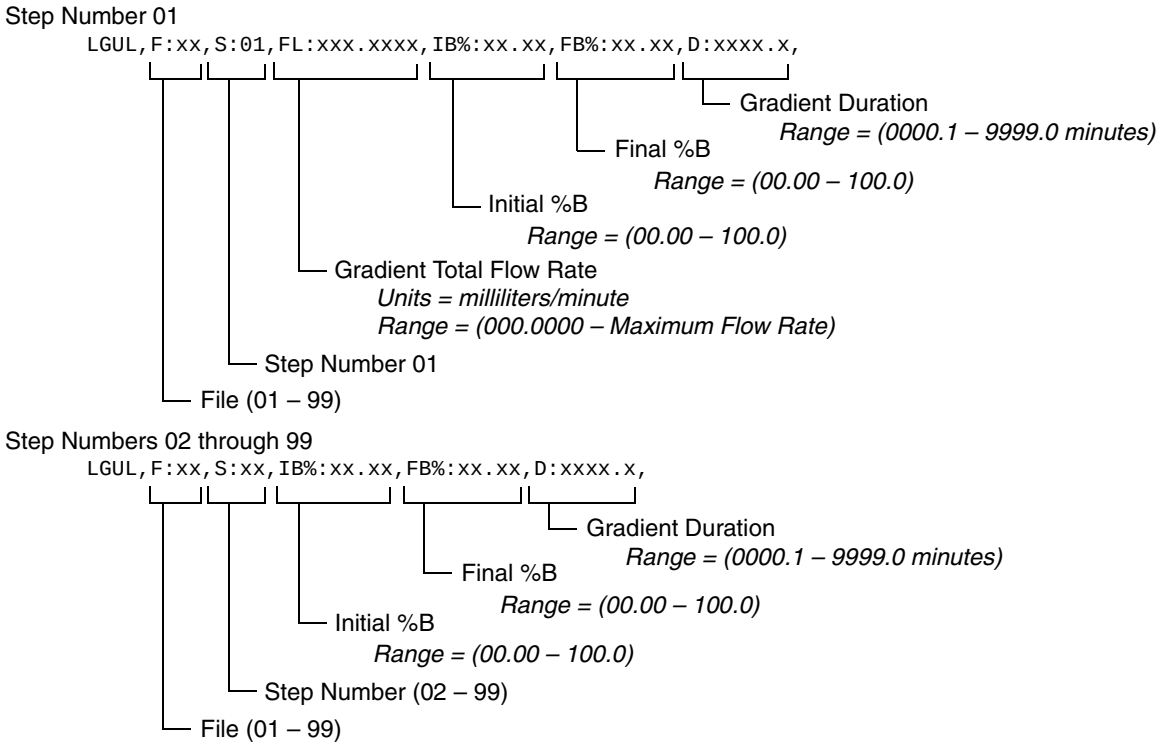


Figure 8-8 Gradient Download Commands - Two pump flow gradient

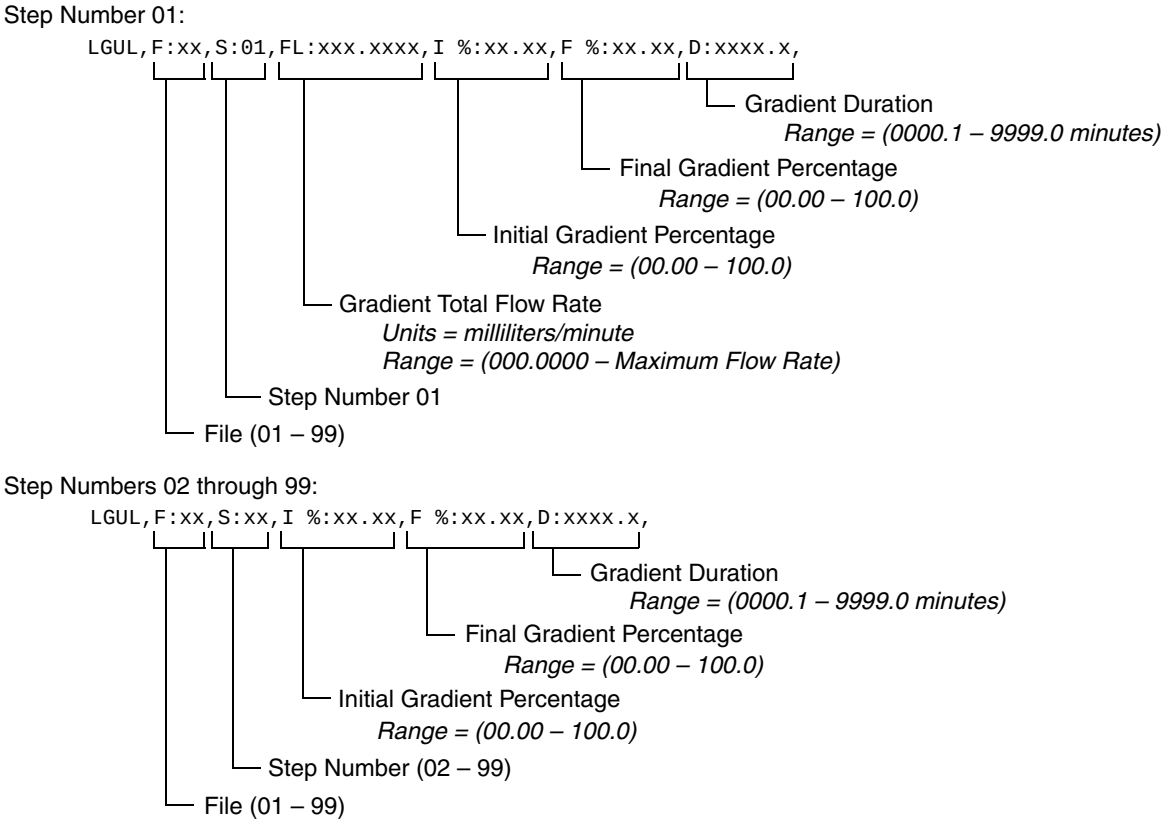

Step Number 01:
LGUL,F:xx,S:01,FL:xxx.xxxx,I %:xx.xx,F %:xx.xx,D:xxxx.x,
Gradient Duration
Range = (0000.1 – 9999.0 minutes)
Final Gradient Percentage
Range = (00.00 – 100.0)
Initial Gradient Percentage
Range = (00.00 – 100.0)
Gradient Total Flow Rate
Units = milliliters/minute
Range = (000.0000 – Maximum Flow Rate)
Step Number 01
File (01 – 99)
Step Numbers 02 through 99:
LGUL,F:xx,S:xx,I %:xx.xx,F %:xx.xx,D:xxxx.x,
Gradient Duration
Range = (0000.1 – 9999.0 minutes)
Final Gradient Percentage
Range = (00.00 – 100.0)
Initial Gradient Percentage
Range = (00.00 – 100.0)
Step Number (02 – 99)
File (01 – 99)

Figure 8-9 Gradient Upload Commands - Single pump flow gradient

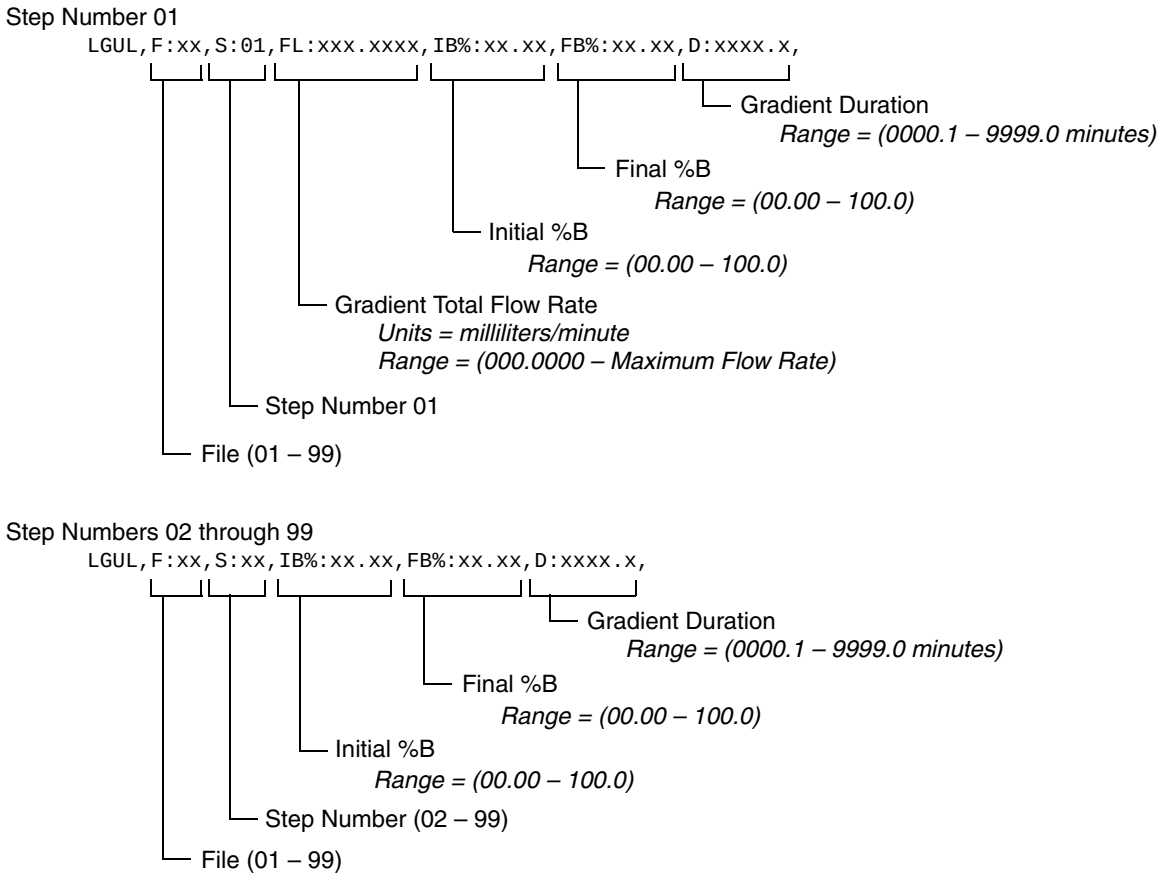


Figure 8-10 Gradient Upload Commands - Two pump flow gradient

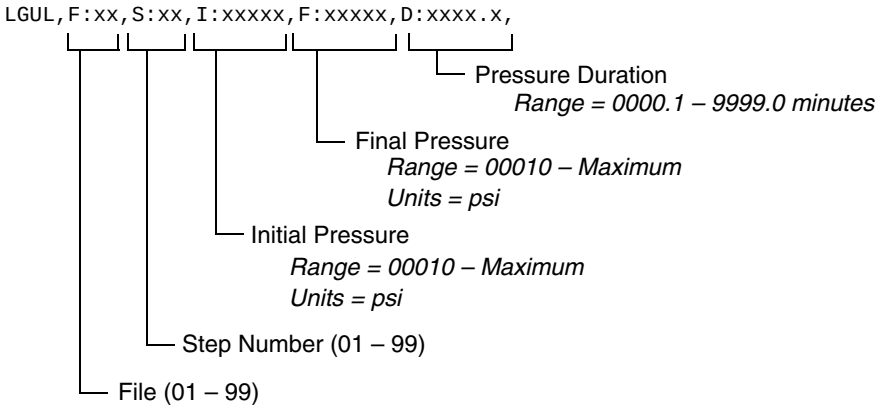


Figure 8-11 Upload Commands - Single pump pressure programming

8.8.4 Range Command

The RANGE command provides scaling information for the system parameters. For example,

6R006RANGEA34

may return a string similar to the one shown in Figure 8-12.

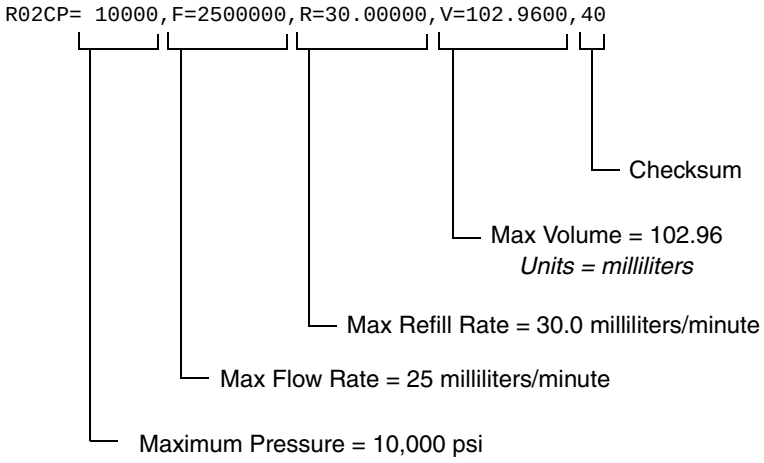


Figure 8-12 Range Serial Commands

8.8.5 Error Messages

If an error occurs in a message, one of the following responses will be sent. The format of an error message is "PROBLEM=_____." Refer to Table 8-7.

Table 8-7 Error Messages

Error	Description
PROBLEM=LOCAL MODE	The pump was sent a command before being placed in remote mode. See Section 8.8.
PROBLEM=INVALID COMMAND	The command sent was not recognized by the pump.
PROBLEM=INVALID OPERAND	The operand (character(s) following the = sign) is missing or is incorrect; *e.g.*, the number was too large.
PROBLEM=PUMP RUNNING	The command sent is only valid when the pump is stopped.
PROBLEM=OVERPRESSURE PROBLEM=UNDERPRESSURE	Sent in response to a high or low pressure limit condition.
PROBLEM=CYLINDER EMPTY	Sent when the pump cylinder is empty.
PROBLEM=CYLINDER FULL	Sent when the pump cylinder is full.
PROBLEM=NO PUMP	Sent when the pump is not present
PROBLEM=WRONG PUMP MODE	Sent when the pump is in the incorrect mode for the command.

D Series Syringe Pumps

Section 9 Pump Maintenance, Troubleshooting, and Servicing

DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

WARNING

Earth ground bonding conductor. Do not remove or disconnect.

Mise à la terre. Ne pas enlever ni déconnecter.

WARNING

Line voltage is present inside this unit at all times, regardless of switch settings. If internal adjustments or repairs are necessary, the line cords must be disconnected to remove possible shock hazard before opening the case.

9.1 Introduction

The following sections contain maintenance and repair procedures which you can do yourself or have done by a technician at your site.

To view the schematic drawings referred to in this section, first find the serial number for your unit. Then go to our Web site at www.isco.com. In the left column, under Service & Support, click **Schematics**.

Enter your serial number in the field provided and click **Get Schematics**. If you need assistance, or don't see the correct schematic for your specific unit, contact our service department.

9.1.1 Service Department

If you have a question about a procedure, need parts information, or need some help, call or email the Teledyne Isco Service department. In your message, be sure to include all the details about your instrument and the nature of the error.

Call the Service Department before returning the unit for factory repair. Often a problem can be solved in the field with just a little extra help.

Contact us at:

Toll free (800) 775-2965
Outside USA, Canada, and Mexico: (402) 464-0231
Email IscoService@teledyne.com

9.1.2 How to Ship Returns

In the rare event that an instrument must be returned for maintenance the following measures must be taken to ensure a proper return:

- Teledyne Isco Technical Service (800-775-2965) must be contacted prior to shipment to obtain a clean return form.
- The applicable MSDS paperwork, of the last substance ran, must be received by Technical Service.
- The syringe pump must be shipped with the cylinders removed from the pumps and any residue completely rinsed with methanol or water.
- Wrap the unit in heavy paper or a plastic bag. If the original box is not available, put the wrapped unit in a strong cardboard box at least six inches longer in each basic dimension than the unit.
- Fill the box equally around the unit with resilient packing material.
- Seal it with strapping tape and ship it to the address on the warranty. The warranty at the end of the manual also describes the conditions under which Teledyne Isco will pay surface shipping costs.

NOTICE

· Do not return the pump without contacting the Teledyne Isco Technical Service.

· Do not return the pump without first providing written guarantee that it has been decontaminated of hazardous or potentially lethal materials.

· Teledyne Isco reserves the right to refuse shipment if no decontamination assurance has been provided prior to shipment. Failure to decontaminate a pump may result in legal action taken by state or federal authorities.

Note

It is very important that the shipment be well-packed and fully insured. Damage claims must be settled between you and the carrier. This can delay repair and return of the unit to you.

9.2 Maintenance Kits

Maintenance kits are available for all pump models, for use in many maintenance and servicing tasks.

Table 9-1 summarizes major kit components. Table 9-2 contains part numbers for each kit.

Table 9-1 Maintenance Kit Contents

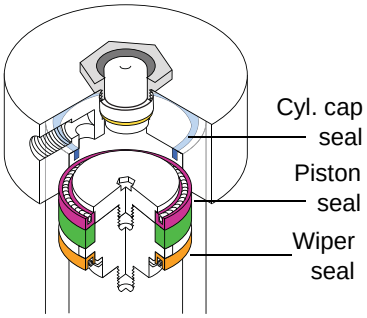
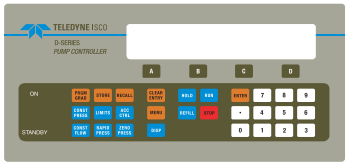
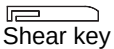
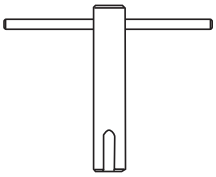
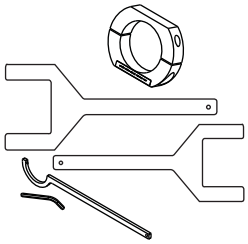
Piston & Wiper Seals- Replace seals annually, at a minimum. Replace more often for applications involving heavy use or harsh/abrasive substances. Cylinder Cap Seal - Replace when removing/installing cap for servicing, or periodically if cap is removed more often (e.g., for spooning in highly viscous substances). 
Control Panel Label - Depending on use, the most frequently pressed keypad buttons may eventually wear out. 
Port Plug
Tubing Connectors
Fuses
Shear Key w/ Installation Tool - If the pump motor fails to stop in the event of an overpressure situation, the shear key may require replacement.    
Wrench Package - Various wrenches for use with most common part replacements. 
Motor Brush Set - Inspect the motor brushes every two years of operation, or every 6,000 piston strokes, whichever comes first (inspect the top brush, which is easier to access). Other option: replace entire motor.
Cable Ties & Mounts, Zero Volume Nut & Ferrule (100D/260D), Universal Sensor Harness (100D/260D/500D)

Table 9-2 Maintenance Kit Part Numbers

Model	Kit
1000D	60-1247-060
500D	60-1247-072
500HPx	60-1247-144
260D	60-1247-073
100D	60-1247-074
65DM	60-1247-094
65D	60-1247-087
30D	60-1249-127

9.3 General Cleaning

For general cleaning of the instrument's front panel or enclosure, use a mild detergent in water or isopropyl alcohol on a sponge which is mostly squeezed out.

The 500HPx contains an inlet fan to cool the motors. Teledyne Isco recommends inspecting and cleaning, if necessary, the inlet fan filter on the 500HPx every six months.

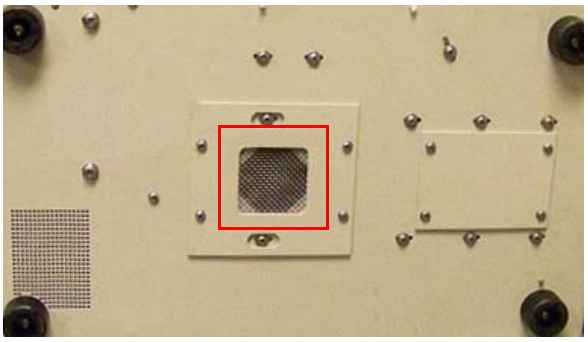


Figure 9-1 500HPx fan filter

9.4 Resetting the System

This action **completely deletes** user programmed settings, erasing all programs and returning the controller to factory default settings. Record your program settings and parameters before performing a reset operation. If ZERO PRESS has been pressed, all corrected offsets will be lost.

9.4.1 Basic Reset

To perform a **basic reset**, press MENU > SYSTEM RESET (5) > CONTINUE (A).

9.4.2 Hard Reset

To perform a **hard reset**:

1. Turn the controller switch to STANDBY.
2. Press and hold CLEAR ENTRY.
3. While still holding CLEAR ENTRY, turn the controller switch to ON. Continue holding down CLEAR ENTRY for one second.

4. Release the CLEAR ENTRY key and turn the controller switch back to STANDBY.
5. Turn the controller switch back to ON, and perform the **Basic Reset**, as described above.

9.5 Diagnostic Menu

The syringe pump controller can run a number of system tests that are initialized using the keypad.

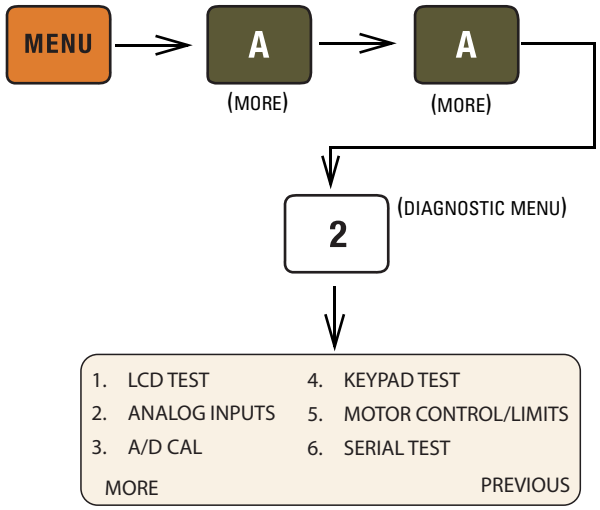


Figure 9-2 Accessing the diagnostic menu

9.5.1 LCD TEST

Cycles all segments of the display through all displayed characters. To stop the test, press any key.

9.5.2 ANALOG INPUTS

Displays the values of all analog inputs in volts. In the left column, with all connected pumps at zero pressure, the pressure readings should be near zero.

After the initial reading, pressurize the pump and then observe the test screen once more to verify that the value for that pump has increased.

The right column represents the four analog input terminals on the rear panel of the controller. For any terminal shorted to ground, the value should read a steady zero.

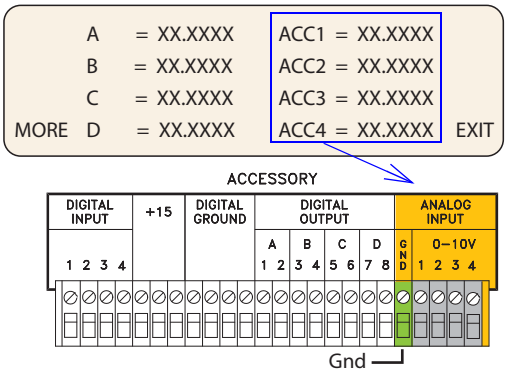


Figure 9-3 Analog Input diagnostic screen

Press EXIT (D) to return to the diagnostic menu.

9.5.3 KEYPAD TEST

The screen will briefly display the name of each key pressed. Press EXIT (D) to return to the diagnostic menu.

9.5.4 MOTOR CONTROL/LIMITS

Tests the digital position controls.

From the Limits menu, you can set minimum and maximum flow rate limits and pressure limits, as well as the maximum flow rate in constant pressure mode. High and low limits cannot exceed pump specifications.

The pump stays within these limits by means of a flag that moves up and down with the ball nut assembly, and two optical sensors at the top and bottom of the tower side plate.

When a sensor is interrupted, it has a logic 1; when it is uninterrupted, it has a logic 0. Therefore:

Top 0, Bottom 1 = Cylinder is full.

Top 1, Bottom 0 = Cylinder is empty.

Top 1, Bottom 1 = Illegal state.

An illegal state can indicate failure of one or both sensors. The controller display will toggle immediately between CYLINDER FULL and CYLINDER EMPTY when you press REFILL or RUN (the pump will not run).

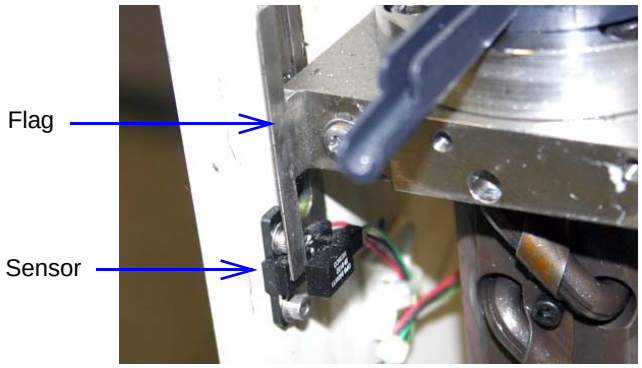
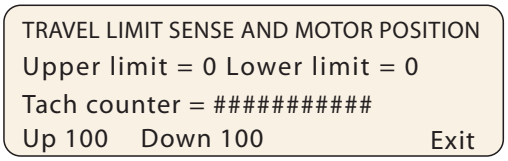


Figure 9-4 Optical sensor, interrupted by flag (bottom sensor shown, rear tower cover plate removed)

Select the pump to be tested (A, B, or C).



Press UP 100 (A) or DOWN 100 (B) to move the piston up or down 100 counts. The tach counter value will increase or decrease by 100 counts, accordingly. When the ball nut assembly reaches the top or bottom of the tower, the corresponding limit will change from 0 to 1. If the cylinder was refilled using the REFILL button,

it may require multiple presses of the 'UP 100' softkey before the 'Lower Limit' indicator changes to 0. When the Lower Limit indicator is 1, pressing the DOWN 100 softkey will have no effect.

If the rear tower cover plate is removed to expose the sensors, as shown above in Figure 9-4, you can simply interrupt the sensors with a slip of paper, rather than using the flag.

If either sensor fails, the sensor harness must be replaced.

Press EXIT (D) to return to the diagnostic menu.

9.5.5 SERIAL TEST

Tests the serial channel.

First, confirm operation of the **internal port**. On the RS-232-C port on the rear of the controller, short pins **2 and 3** and then run the test. The screen should display:

```
Rec: ****** Serial Test #### *****
Sent: ****** Serial Test #### *****

Press any key to exit
```

The four digits in the REC line should match the four digits in the SENT line, with a very slight delay.

If the unit passes the internal port test, next perform the **I/O** test. Use a null-modem cable (available from Teledyne Isco, part #480-7996-00) to connect the 9-pin serial output port of a computer to the RS-232-C port, as shown on the following page.

> ☑ ***Note***
>
> Avoid using a USB converter cable; test results have not been shown to be dependable.

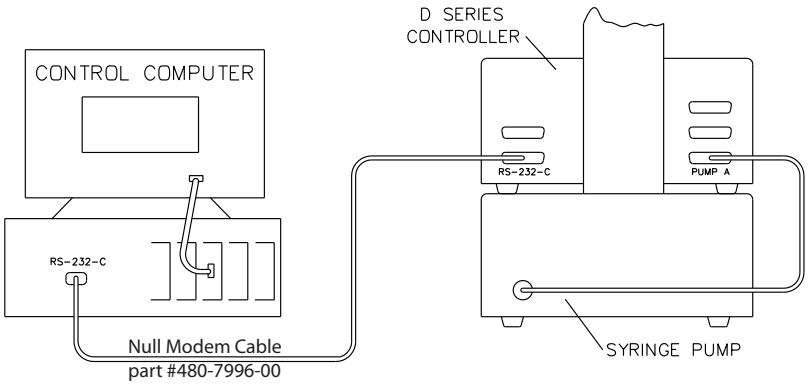


Figure 9-5 Serial connection to a computer

Open a terminal emulator program such as HyperTerminal (©Hilgraeve, Inc. Monroe, MI). The factory default port settings are:

BPS - 9600. Baud rate should match controller setting (refer to Section 8.2)

Data bits - 8

Parity - None

Stop bits - 1

Flow control - None

Run the test again. The screen should display:

```
Rec: [whatever is typed from PC]
Sent: ****** Serial Test #### *****

Press any key to exit
```

Anything typed on the computer keyboard should appear in the top line on the controller display. The computer should continually display the serial test shown in the second line of the controller display.

9.6 Removing the Case Top

For some maintenance procedures, the case top of the controller or the pump may need to be removed. Because interior access is easier with the controller, this method of troubleshooting should be used whenever possible.

⚠ ⚠ DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

⚠ ⚠ DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

9.6.1 Controller Case Top Removal

Troubleshooting for a number of issues can be done on the controller main circuit board. Remove the four screws holding the case top in place (two screws on each side). Lift the cover straight up and off.

Figure 9-6 Controller case top screws (2 of 4 shown)

9.6.2 Pump Case Top Removal

Some maintenance and troubleshooting procedures require accessing the pump module interior. Remove the four screws holding the case top in place (two screws on each side). Lift the cover straight up and off.

> **Note**
>
> For the 30D remove the 6 screws holding the case top in place (3 on each side).

Figure 9-7 Pump case top screws (2 of 4 shown)

9.7 Test Points

The following sections contain tables listing the most commonly used test points and their voltages. Refer to the controller schematic and the pump schematic (available online on our Web site).

⚠ ⚠ DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

⚠ ⚠ DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

9.7.1 Power Supply (A1)

Output voltages of the power supply can be verified. The voltages in the pump unit, between circuit common (TP106) and the fuses or at the test points should be:

F104	+22 VDC	to +31 VDC
F103	+8.1 VDC	to +13 VDC
F102	–22 VDC	to –31 VDC
TP111	+15 VDC	± 0.6 VDC
TP110	–15 VDC	± 0.6 VDC
TP109	+5 VDC	± 0.3 VDC

The voltage between motor common (TP101) and +VM (TP105) should be +60 to +90 V. See section 4.

9.7.2 Controller

The voltages in the controller unit between circuit common (TP16, TP5, TP6) and the test points should be:

TP32	+5 VDC	± 0.002 VDC
TP12	+8.1 VDC	to +13 VDC
TP43	–15 VDC	± 0.6 VDC
TP44	+15 VDC	± 0.6 VDC
TP20	+3.3 VDC	± 0.0 VDC
TP9	+2.5 VDC	± 0.0 VDC
TP7	+1.5 VDC	± 0.0 VDC

☑ ***Note***

These voltages are displayed during the Analog Input routine in the Diagnostics section of the firmware (Section 9.5.2).

9.8 Lubrication

The pump is a precision engineered instrument that must be lubricated every two years or every 6,000 strokes (whichever comes first) to ensure proper service life.

The pump has an easy-to-access lube wheel that keeps the main gears lubricated during operation. See Figure 9-8, configuration 1 or 2, depending on your pump motor type. For your convenience, a lubrication kit (containing Never-seez® and DUOLEC® 1608 lubricants) is included in your pump accessory package.

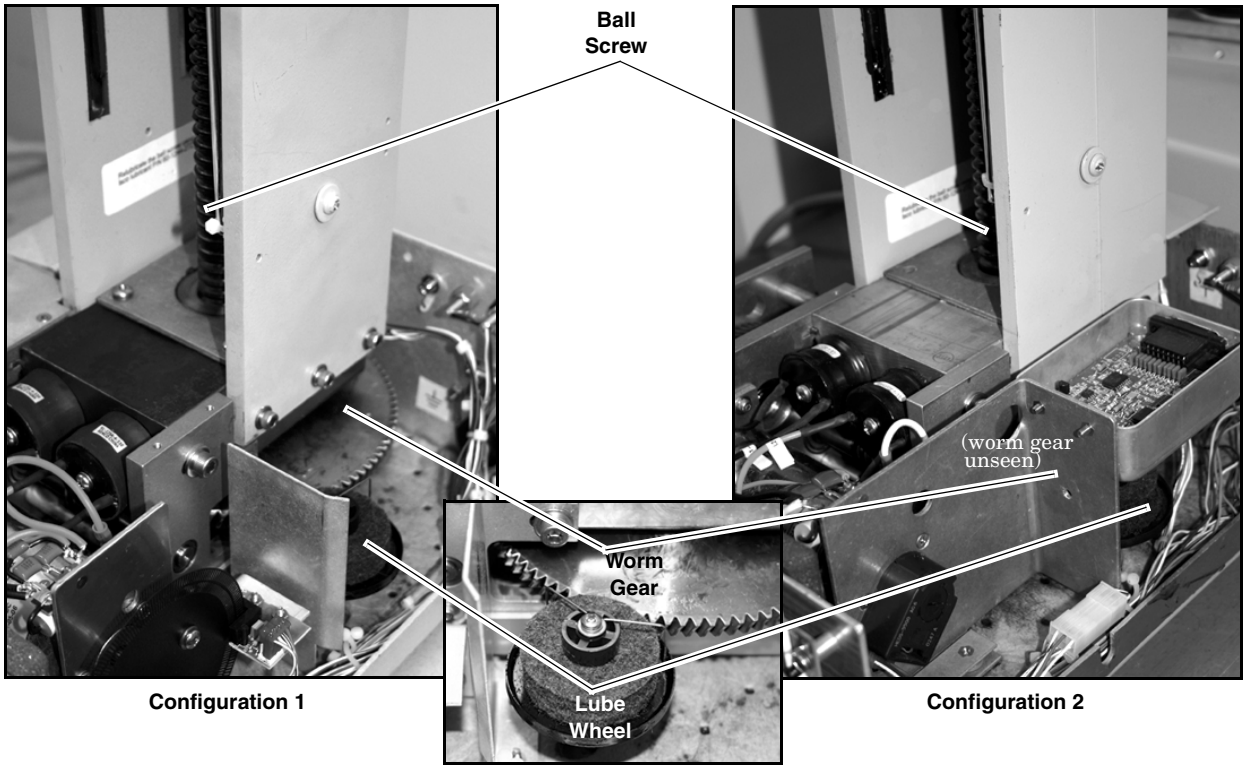


Figure 9-8 Gear train lubrication and motor drive service

Worm / Worm Gear

The worm and worm gear are lubricated by a lubrication wheel. Apply DUOLEC 1608 directly to the wheel until it is saturated. The wheel may also be directly lubricated by trickling oil into the wheel while the pump is running.

> ☑ ***Note***
>
> Use only DUOLEC 1608 lubrication on the worm and worm gear. Do not substitute.

9.8.1 Ball Nut

The ball screw, which drives the ball nut, must be kept lubricated with Never-seez.

1. Remove the case top, as detailed in section 9.6, and front cover to gain access to all parts requiring lubrication.

2. To lubricate the ball nut, run the pump until the ball nut reaches its maximum height.
3. Apply two beads of lubricant, on opposite sides of the ball screw, down its entire length.

The precision thrust bearing at the base of the ball screw (refer to Figure 9-8) is factory lubricated and should not need re-greasing.

9.9 Seal Cleaning and Replacement

Before cleaning or replacing the piston or wiper seals, the cylinder must first be emptied.

☑ *Note*

30D has its own set of seal replacement instructions which are included in the seal replacement kit. The following instructions do not apply to the 30D. The 30D uses a special tool, including in the kit, that is necessary for the seal replacement.

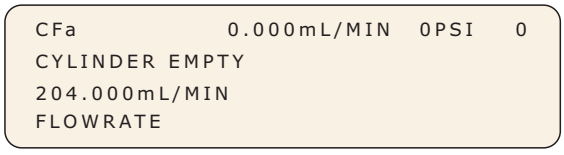
⚠ CAUTION

Handle with care. Never let surfaces of seals, piston, or cylinder come into contact with abrasives or fingernails.

Tools required:

- ¼" and ⅛" Allen wrenches
- #2 Phillips screwdriver
- Wrench set from maintenance kit
- Never-Seez lubricant from accessory package

1. Run the pump until empty.



2. Disconnect the power cord and pressure transducer cables, and plumbing connections from the pump.
   Wrap the transducer cable around the cylinder cap.
3. Using a ⅛ Allen wrench, loosen the lock screw located on the front of the cylinder mounting block about two turns.
4. Unscrew the cylinder using either a strap wrench or the clamp and wrench in the Teledyne Isco wrench package (60-1247-130 for 65D and 65DM, 60-1247-067 for 100DM, 100DX, and 260D; 68-1247-068 for 500D; 60-1247-145 for 500HPx; 60-1247-093 for 1000D), which will not mar the cylinder's outer surface.

5. Once the cylinder has been unscrewed, lift it straight up and off the piston and the push tube.

⚠ CAUTION

Do not tilt the cylinder while removing it. Seal damage can result.

9.9.1 Piston Seal (Excludes 30D)

Sometimes dirt or other solids on the seal can cause leakage. Removing and cleaning the seal may stop the leak and a new seal may not have to be used. However, if you remove and inspect the seal and it does not have any obvious crease or you did not find any foreign material on the seal, then the seal must be replaced. Check the wear ring. See Section 9.10.

☑ *Note*

DO NOT use abrasives while cleaning the piston and piston seal area. Scratches caused by the use of such abrasives will cause leaking. If either the cylinder or seal has been scratched, it must be replaced to maintain flow rate specifications.

☑ *Note*

If your pump uses polyethylene piston seals, be sure to follow the special instruction below for this type of seal.

Accessing the piston seal

1. Unscrew the piston seal retainer (Figure 9-9) from the piston and remove the seal from it. Notice that the spring imbedded in the seal is facing up or is on the top side of the seal.
2. Clean both the piston seal retainer and the cylinder thoroughly. Make sure all parts which come in contact with the seal are free of dirt and other solids.
3. Once the seal and cylinder surfaces have been cleaned, rinse both parts with isopropyl alcohol.

9.9.2 Piston Seal Break-In (Aqueous seals only)

The break-in procedure is intended only for the UHMWPE (aqueous) piston seal, to prevent the spring from bowing out its shape.

1. Assemble the piston assembly per Figure 9-9A. Be sure to install the top seal on the piston with the spring facing down.
2. Slide the cylinder over the piston assembly, per Figure 9-9B, and allow it to sit for 15 minutes. This “breaks in” the seal for the steps that follow.
3. Remove the cylinder.
4. Reassemble the top seal with the spring facing up, per Figure 9-9C.

5. Install the cylinder over the piston assembly, again, and screw onto the mounting block.
6. Leak test the pump.

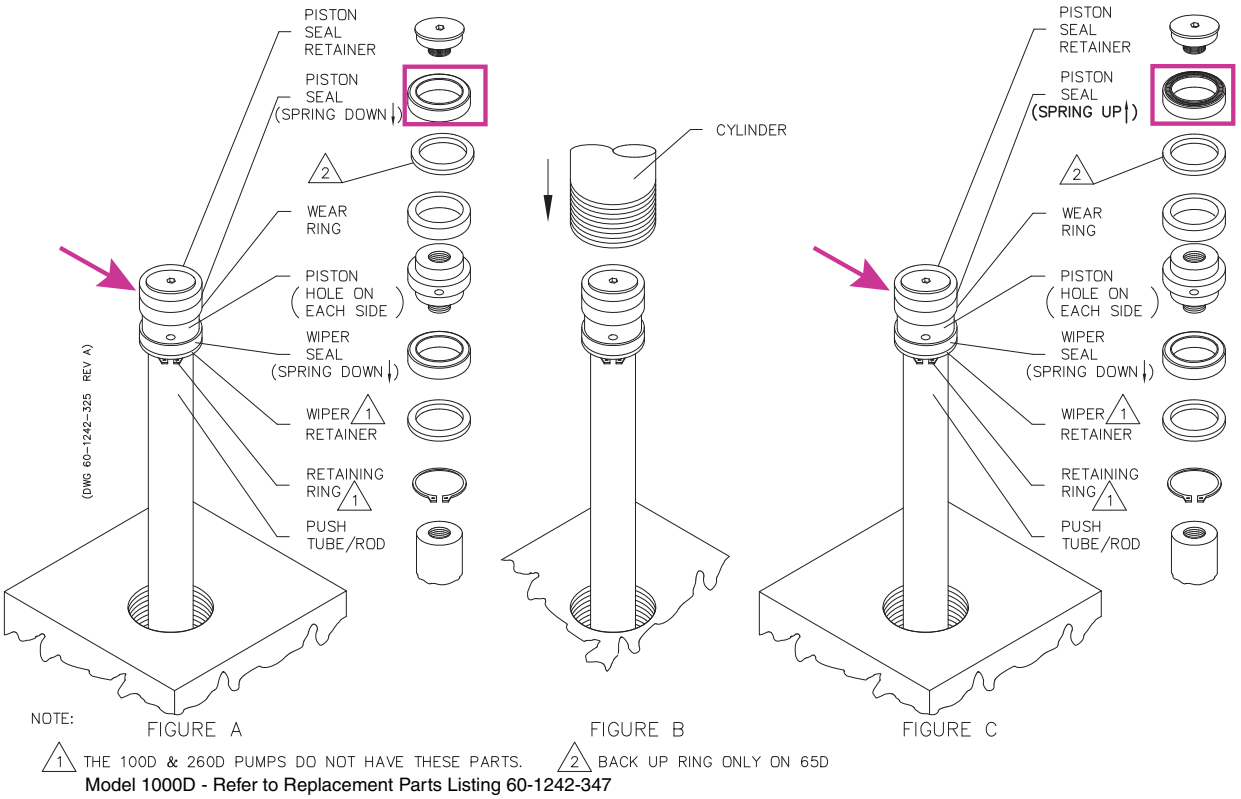


Figure 9-9 Break-in procedure for aqueous seals (Drawing does not apply to the 30D)

> **Note**
>
> For the 30D pump, see the "30D Syringe Pump Seal Replacement" instruction sheet included with the seal or piston assembly kit.

9.9.3 All other piston seals

1. Access the piston seal as previously described.
2. Orient a new seal so that the spring in the seal is facing up.
3. Slide the seal onto the piston.
4. Replace the piston seal retainer.

9.9.4 Wiper Seal (Excludes 30D)

Although the wiper seal does not normally have to be changed, periodic cleaning is advisable.

Removal and cleaning

1. Access the cylinder as described previously.
2. Locate the piston (Figure 9-9).

3. With the exception of the 500D, which has wrench flats, use a spanner wrench with an 1/8" pin of appropriate size or the proper tool from the Isco wrench package in the round hole on the side of the piston.

   Teledyne Isco has piston wrench tools, which are also included in the wrench packages for each model of pump. Refer to Table 9-3 on the following page.

Table 9-3 Piston Wrench Tools

Pump Model	Part Number
65D, 65DM	Piston wrench tool 69-1243-905 Wrench package 60-1247-130
30D	Refer to the 30D Seal Replacement Instruction included in the seal replacement kit Wrench package 60-1249-132
100DM, 100DX	Piston wrench tool 69-1243-888 Wrench package 60-1247-067
260D	Piston wrench tool 69-1243-889 Wrench package 60-1247-067
500D	Piston wrench tool 69-1243-890 Wrench package 60-1247-068
500HPx	
1000D	Piston wrench tool 69-1243-788 Wrench package 60-1247-093

4. Use the tool to twist the piston loose, then unscrew it by hand.
5. Remove the retaining ring (500D only) and wiper retainer, then lift off the wiper seal. Being careful not to scratch any sealing surfaces, gently break free any solids from the seal and piston. Rinse all the solids away with distilled water.

Reinstalling the wiper

1. Install the piston seal onto the retainer with the spring oriented towards the retainer.
2. Install the wiper seal onto the piston base with the spring facing down.

> ☑ ***Note***
>
> In the Model 1000D pump, and the 500D with wash gland option, the wiper seal is installed with the spring facing **up**.

3. Place the piston base onto the push tube.
4. Install the piston seal retainer onto the piston base.
5. Replace the cylinder over the piston and push tube assembly and screw it into the cylinder mounting block. The cylinder should be screwed into the cylinder mounting block until the cylinder bottoms firmly against the stop ring in

the cylinder mounting block (the cylinder will no longer turn). Do not **overtighten**.

6. Unscrew the cylinder until the inlet and outlet ports are lined up as you had them before. Do not unscrew the cylinder more than one full turn from the stop position.
7. Lock the cylinder by tightening the locking screw on the front of the cylinder mounting block to 30 in-lbs (3.4 N-m). Reinstall covers.

9.10 Wear Ring Cleaning and Replacement

Although the wear ring does not routinely need to be replaced, occasionally it becomes worn or damaged, depending on how the pump has been used. Teledyne Isco recommends that when replacing the seal or cleaning the piston, check the wear ring for any signs of deterioration.

1. Follow the instructions in section 9.9, Seal Cleaning and Replacement, to access the cylinder.
2. Remove the piston seal retainer and slide off the seal. The wear ring should then slide easily up and off the piston.

The wear ring prevents the piston from direct metal-to-metal contact with the cylinder wall, and should, therefore, extend at least 0.010" beyond the circumference of the piston lip. Check the bottom of the wear ring, which rests on the piston lip, for extrusion or any unevenness. If there is an indentation (of 0.0010" or more) marking the outline of the piston lip, then you should replace the wear ring. However, if the surface is smooth, the wear ring does not need replacing.

9.11 Flushing the Cylinder

After cylinder/seal maintenance or during modifier (liquid solvent) change, the pump cylinder should be flushed to remove possible residue.

The way in which the cylinder is flushed will depend on your pumping system and whether you are pumping a liquefied gas such as CO_2 (see Section 9.11.1) or a liquid modifier such as methanol (see Section 9.11.2).

9.11.1 Gas Solvent Changeover

This procedure is used when changing from one gaseous solvent to another.

1. Close the valve on the fluid supply tank so that no solvent is supplied to the system.
2. Turn the controller ON.
3. Run the pump until the cylinder is empty. If there was any pressure in the system, wait until all the pressure bleeds off.
4. Change the solvent tank.
5. Close the pump outlet valve.
6. Open the valve on the tank to repressurize the system.

7. Cycle the pump between REFILL and RUN a few times, opening and closing the appropriate valves at the proper time to purge any remaining gas from the pump. Use about 10 - 20 mls per stroke to purge.

9.11.2 Liquid Solvent Changeover and Flushing

This procedure is typically used for modifier systems when changing from one liquid solvent to another.

> **☑ Note**
>
> If high ionic strength aqueous reagent solutions are allowed to remain in the pump, solid residues may be formed, which will scratch the seals and the polished inner surface of the cylinder of the pump. These scratches allow leakage, which decreases flow rate.

To clean the cylinder

1. Press CONST FLOW > RUN. You will be asked to designate which pump if more than one is present.
2. Press a softkey to run the desired pump.
3. Run the pump until the message “CYLINDER EMPTY” is displayed.
4. Place the pump inlet line in a flask containing a compatible solvent or a detergent solution.
5. Press REFILL. You will be asked to designate the pump to refill if more than one is present. Press a softkey to refill the pump.
6. Fill the pump and repeat this procedure several times.
7. Place the pump inlet line in a flask containing distilled water or appropriate solvent. Fill the pump once more and then run it until empty. You are now ready to fill the pump with the new liquid solvent.

> **☑ Note**
>
> Do not leave buffer solutions which contain dissolved salts or corrosive buffers in the cylinder overnight or for long periods of time. The pump should be stored with methanol or isopropanol (at least partially fill the cylinder with either solvent and then run the piston all of the way up) when it is not being used.

9.12 Overpressure Conditions

The operator can set the maximum pressure limit on the pump controller (refer to Section 3.8.7). The pump can be set to stop running if an overpressure condition occurs.

The shear key is located in the worm gear assembly of the pump. Should the maximum pressure circuit fail and excessive pressures (pressures that exceed maximum pressure limits) persist in the operation of this pump, the torque limiting shear key may become damaged. The shear key will yield at pressures slightly above maximum pressure, and it will break around 1.5 times the pressure rating.

In the event of a shear key failure, the pump will sound as though it is turning, but the piston will not move up the cylinder. When this occurs, the pump motor will not stop automatically.

Damage to the pressure transducer and push tube could be possible if the key failed due to extreme overpressure.

⚠ WARNING

The shear key is NOT a safety feature! It provides a measure of protection against damage to the equipment. Avoid overpressure situations by properly installing and programming the pumping system. In applications where overpressure conditions are possible, install an appropriate pressure relief safety device in your apparatus.

9.12.1 Shear Key

Table 9-4 below provides part numbers for each pump model replacement shear key.

Table 9-4 Replacement Shear Keys

Pump Model	Part Number
1000D, 500HP, 260D, 65D, 500HPx	60-1243-607
500D	60-1243-654
100DM/DX	60-1243-608
65DM	60-1243-949
30D	60-1263-131

1. Place the pump on its side and remove the four panhead screws that attach the access plate to the case bottom, as shown in Figure 9-10.
2. Remove the cotter pin that passes through the castle nut and ball screw.
3. Use a ¾" wrench to remove the castle nut, shown below.
4. Remove the spacer.
5. The two broken halves of the shear key should be protruding from the brass worm gear and the ball screw.

☑ *Note*

The 30D or 65DM pumps have a bearing set not included in the other pumps. In addition to following the other steps in this section, when performing shear key replacement on a 30D or 65DM pumps, ensure that the bearing set is properly reinstalled, as described in Section 9.12.4.

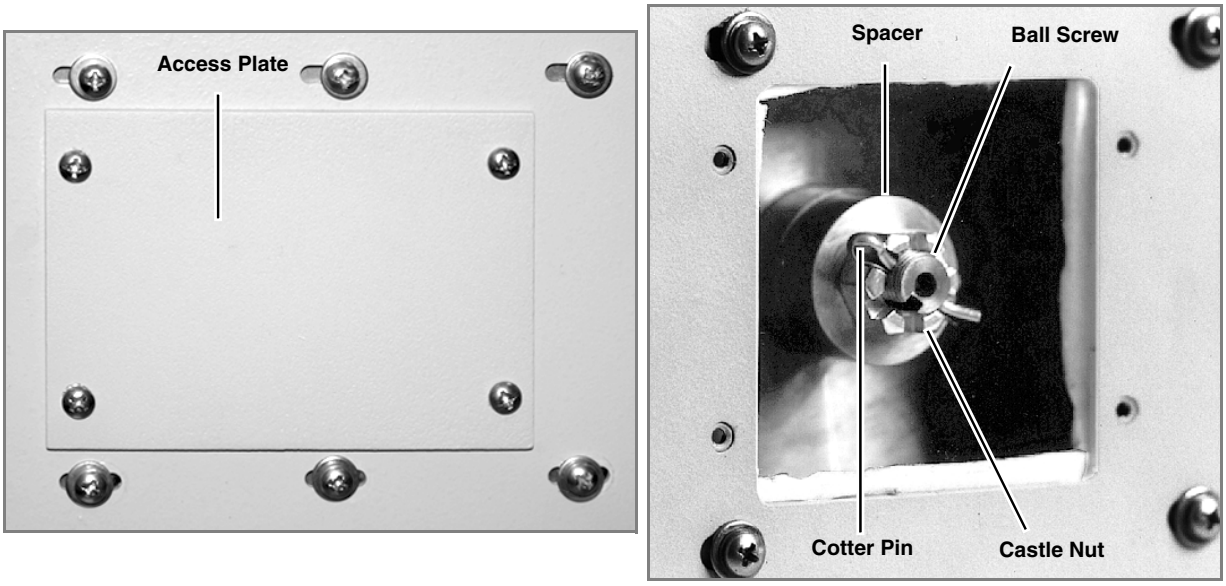


Figure 9-10 Accessing the shear key

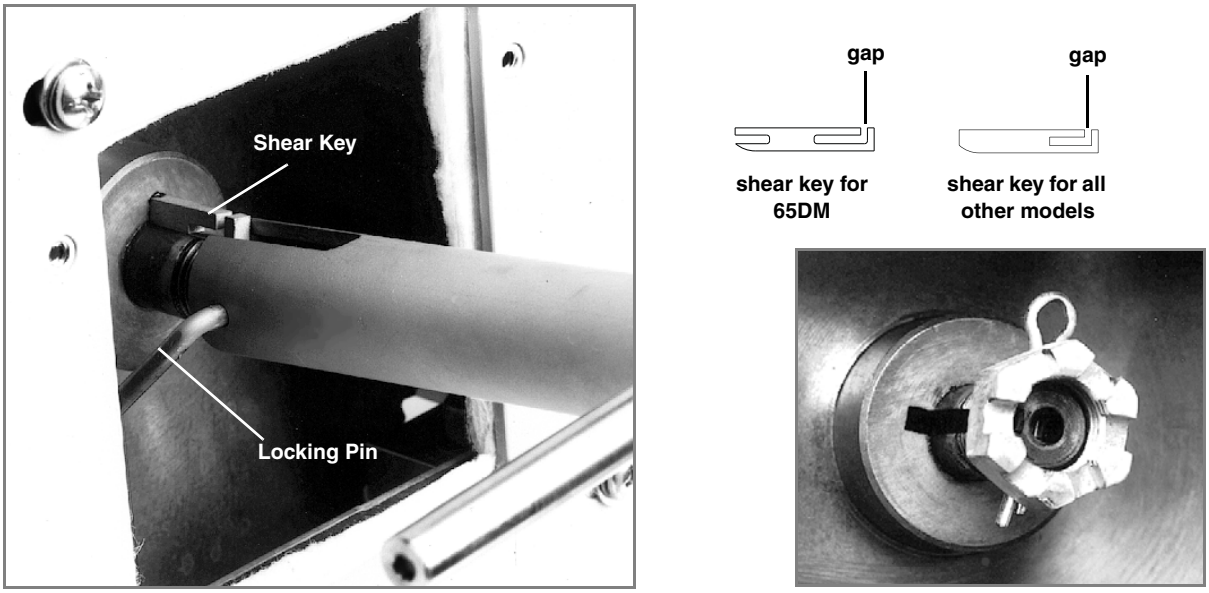
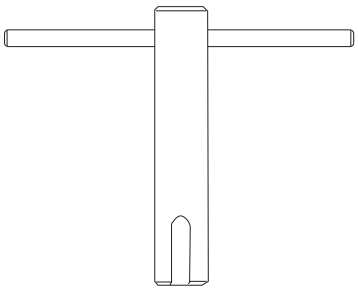


Figure 9-11 Shear key replacement

9.12.2 Replacement Using Installation Tool

A shear key installation tool (part #60-1248-135) is available from Teledyne Isco.



1. Insert tool into ball screw so that the slot on ball screw and tool are lined up, then lock with locking pin.
2. Rotate the ball screw until the broken halves of shear key are realigned (Figure 9-11).
3. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
4. Insert the new shear key into the slot with the gap facing away from the shaft, as shown in Figure 9-11. Push the shear key about half-way into the worm gear. Do not push it all the way in.
5. Remove the tool and proceed to the final steps in Section 9.12.5.

9.12.3 Replacement Without Installation Tool

1. Follow steps 1 through 5 in section 9.12.1.
2. Insert the cotter pin into the ball screw, and screw the castle nut onto ball screw, with the slot on castle nut outward, as shown in Figure 9-11.
3. Use a ¾" wrench on the castle nut and rotate the ball screw clockwise until the broken halves of the shear key are realigned (Figure 9-11, above).

⚠ CAUTION

Never use tools on the ball screw. Doing so will render it inoperable and beyond repair.

4. Remove the castle nut and cotter pin.
5. Remove the broken shear key halves by gripping them with pliers or vise grips and pulling them out.
6. Insert the new shear key into the slot with the gap facing away from the shaft, as shown in Figure 9-11. Push the shear key about 1/2-way into the worm gear. Do not push it all the way in.
7. For 65DM pumps, proceed to the next section. For all other pump models, proceed to the final steps in Section 9.12.5.

9.12.4 Pump Bearings (30D and 65DM Only)

Follow the step by step instructions in Section 9.12.2 *Replacement Using Installation Tool*, or in Section 9.12.3 *Replacement Without Installation Tool*. Then proceed with the instructions in this section.

The 30D and 65DM pumps have an outer bearing set not included in the other pumps. The set includes two thrust washers and one thrust bearing (see Figure 9-12).

Figure 9-12 30D and 65DM Bearing set

Note that the 30D and 65DM spacer is shaped differently from that of the other pumps, and must be properly oriented during reinstallation, Figure 9-13.

When performing shear key replacement on the 30D and 65DM pumps, use care to keep the bearings in position, with the bearing between the two washers, while installing the spacer.

Proceed to the final steps in Section 9.12.5.

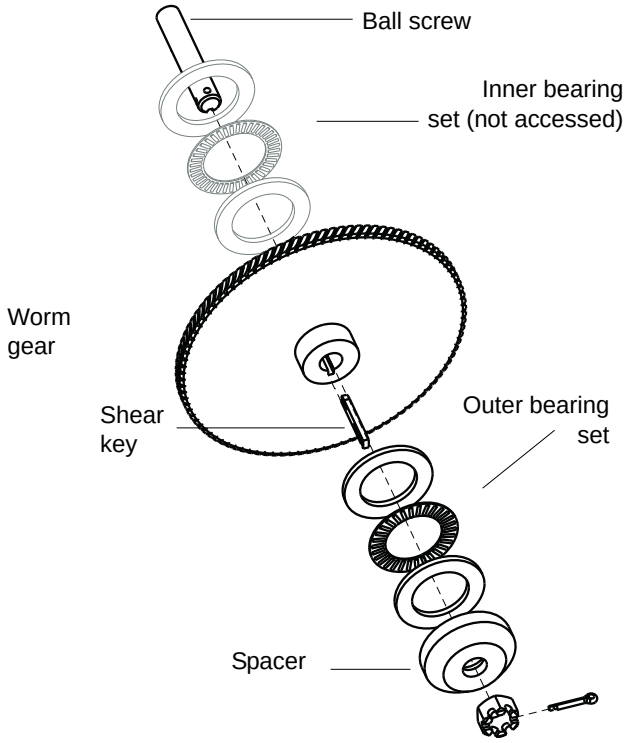


Figure 9-13 30D and 65DM Shear key replacement

9.12.5 Completion of Shear Key Replacement

1. Slide the spacer onto the ball screw. The spacer will push the shear key into proper position. Install the castle nut on the ball screw. If the shear key isn't completely in the slot, the spacer will position it properly as the castle nut is tightened.
2. Tighten the castle nut.
   a. For the 30D and 65DM, torque to **200 in-lbs (23 N-m)**. Do not exceed this limit, or damage to the bearings will occur.

b. For all other models, torque to **250 in-lbs (28 N-m)**.

3. Loosen the nut until it can be turned by hand. Tighten the nut finger tight.
4. Torque the castle nut to 100 in-lbs.
5. Insert the cotter pin through the castle nut and ball screw. If the holes do not line up, loosen the castle nut slightly until any set of holes allow the cotter pin to be inserted.

⚠ CAUTION

Do not loosen the nut more than 30° beyond the torqued position to align the holes.

6. Reinstall the access cover.

9.13 Motor Brushes

If the pump does not run properly, one possible cause is worn brushes.

Inspect the motor brushes every two years of operation, or every 6,000 piston strokes, whichever comes first. Both brushes wear at approximately the same rate; therefore, only the top brush, which is more easily accessible, need be inspected.

⚠ ⚠ DANGER

RISK OF ELECTRIC SHOCK - DISCONNECT THE ELECTRIC POWER BEFORE SERVICING. ONLY TRAINED SERVICE PERSONNEL MAY REMOVE THE CASE TOP.

⚠ ⚠ DANGER

RISQUE DE CHOC ÉLECTRIQUE. COUPER L´ALIMENTATION AVANT LA RÉPARATION. L´USAGER NE DOIT PAS DÉMONTER L´INSTRUMENT OU DÉRANGER LE MÉCANISME DEDANS. ADRESSER LA REPARATION SEULEMENT AUX TECHNICIENS COMPÉTENTS.

☑ *Note*

For HPx pumps please refer to Section 9.13.2 for the motor brush replacement procedure.

The bottom brush is accessed through an opening in the bottom of the pump module.

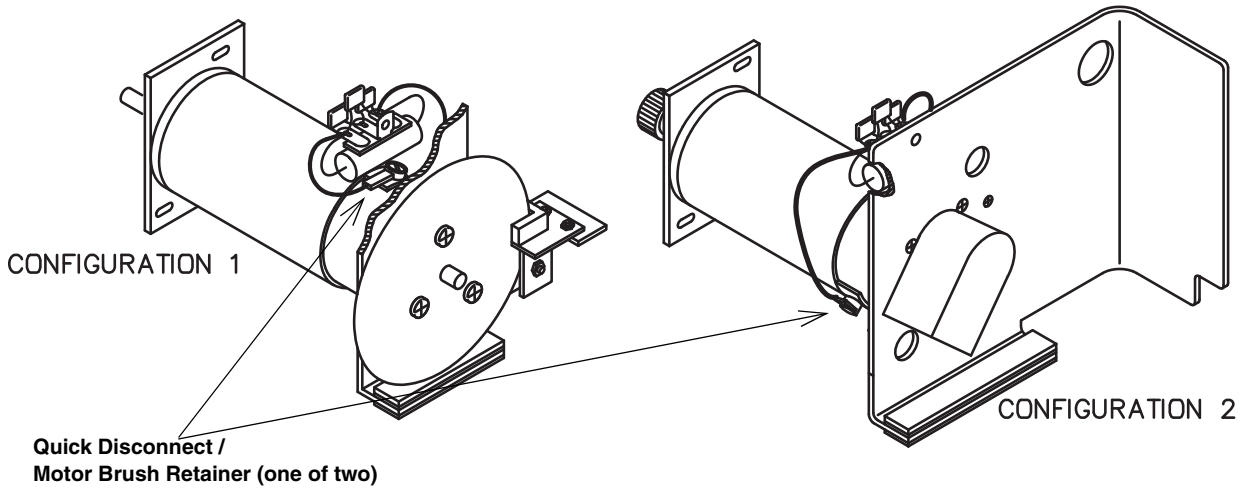


Figure 9-14 D Series motor brush replacement

Note

Parts for Configuration 1 and Configuration 2 are not interchangeable.

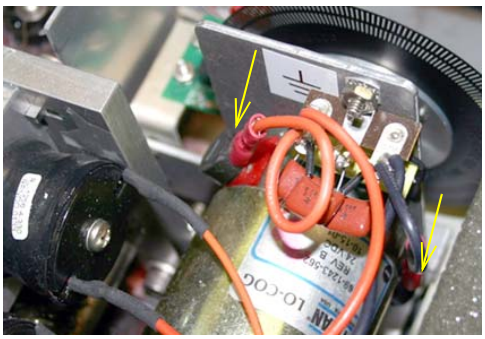


Figure 9-15 Location of motor brushes

A new brush is 1.1 cm long. Brushes should be replaced before they reach 0.4 cm.

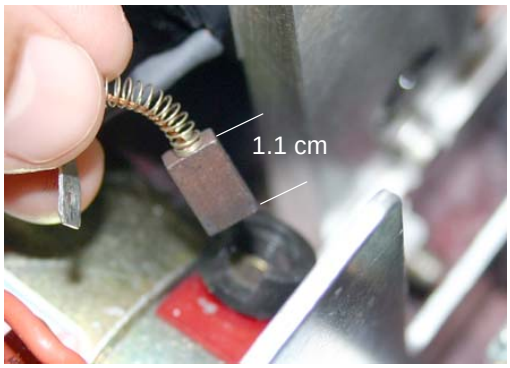


Figure 9-16 Length of a new motor brush (1.1 cm)

1. Unscrew the brush retainer from the motor using a straight edge screwdriver.
2. Pull the brush out of the slot and measure its length. If it is nearing 0.4 cm, replace both brushes.

> **Note**
> Alternatively, the entire motor can also be replaced. For longer-lived optimal performance, replace the motor when the brushes wear down.

9.13.1 Motor Brush Disassembly

1. Remove the wire lead by pulling on the spade connector.
2. Unscrew the brush retainer from the motor using a straight edge screwdriver.
3. Pull the old brush out of the slot.
4. Connect the new brush to the wire lead.
5. Insert the new brush into the slot (needlenose pliers recommended).
6. Push the spring down into the slot in the motor. You may need to use the edge of the screwdriver to gently press the metal tabs on the spring down into the slot.
   Reinstall the brush retainer, tightening it with the screwdriver (do not overtighten).

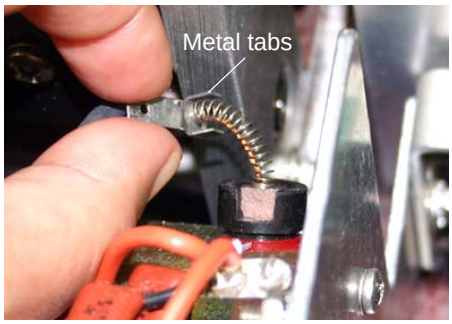


Figure 9-17 Inserting new motor brush

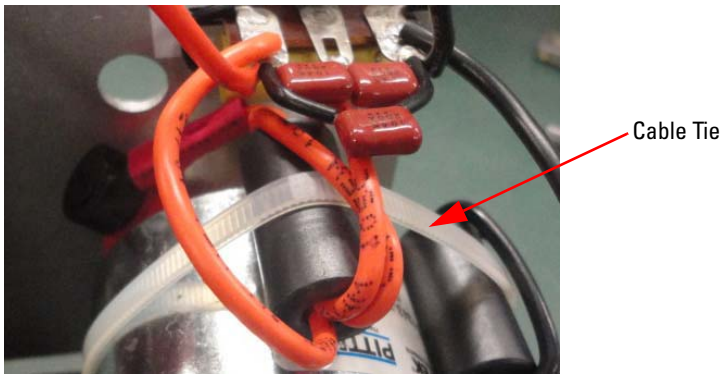


Figure 9-18 For 30D a cable tie holds the wires together

9.13.2 HPx Motor Brush Replacement

This section goes through the various steps needed to replace the HPx motor brush. The following tools are required:

- #2 Phillips screwdriver
- Flat-blade screwdriver
- $^{7}/_{64}$" hex wrench

> **Note**
> Completely read these instructions before proceeding.

Disassembly of Motor Brush

1. Remove the two screws and flat washers that hold the deflector shield in place, then remove the plate (Figure 9-19).

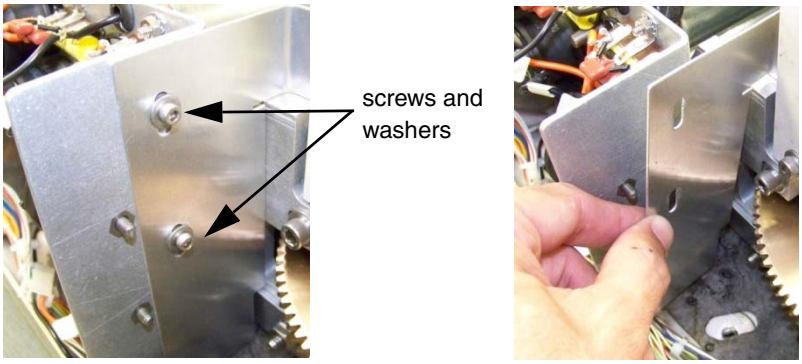


Figure 9-19 Remove screws and washers, then the plate

2. Lay the pump on its side and remove five screws and lock washers, on the bottom of the pump, that secure the circuit board mounting plate and the motor mounting plate to the bottom of the case (Figure 9-20).

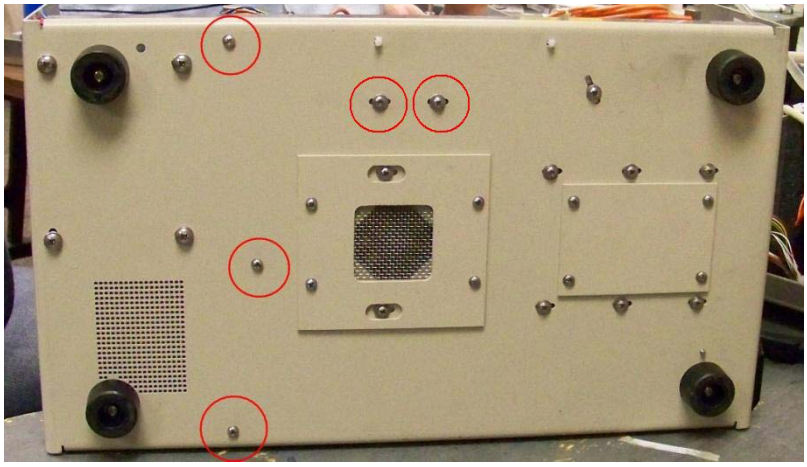


Figure 9-20 Remove the five screws from the bottom of the pump

3. Return pump to an upright position.

4. Unplug the two pin connector (Figure 9-21).

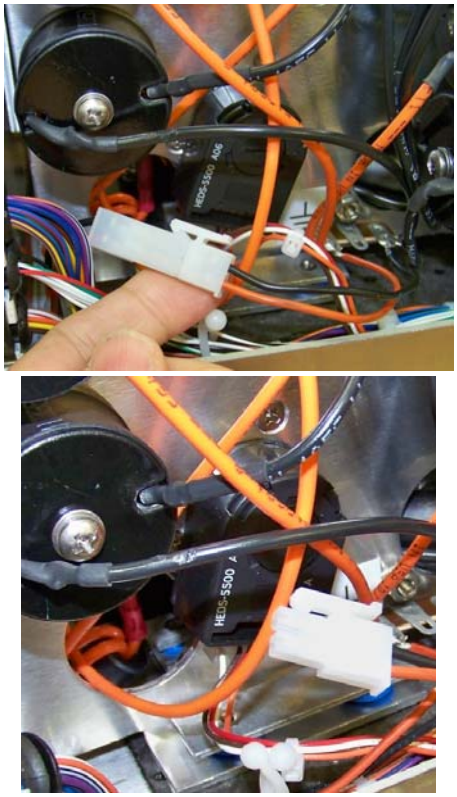


Figure 9-21 two pin connector

5. Unplug connector from the encoder by carefully pulling down on the connector.

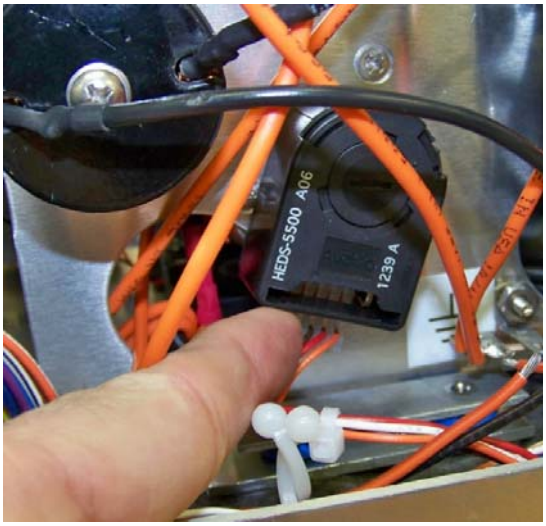


Figure 9-22 Encoder

6. Remove the three screws and three flat washers that hold the motor plate onto the bearing plate. Two of the screws are on top and the third screw is down below the fan (Figure 9-23).

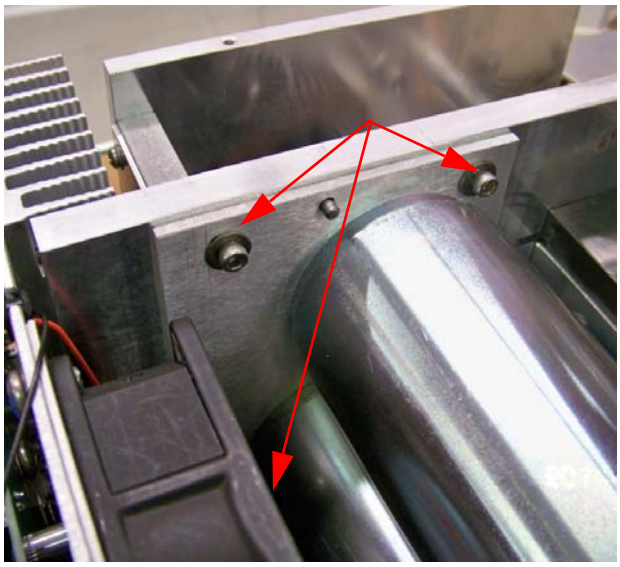


Figure 9-23 Location of screws and washers holding the motor in place

7. Slide the motor assembly straight back until the motor gears clear the bearing plate, then lift the motor assembly completely out of the case.

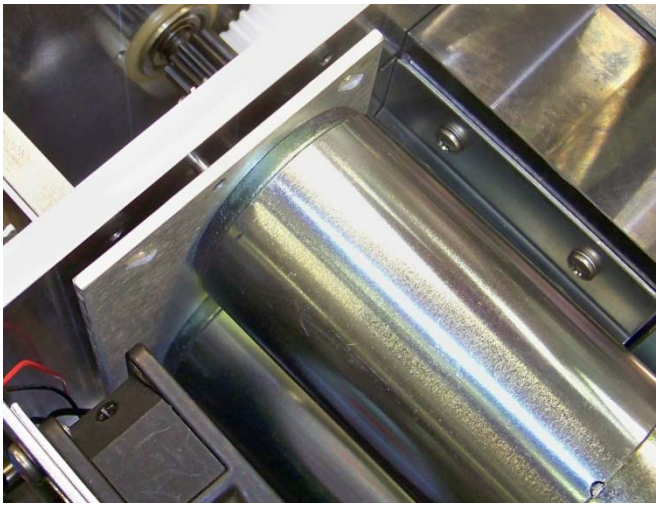


Figure 9-24 Motor assembly

8. The small support plate on the bottom of the mounting plate is adhered with doubled sided tape. Remove the support plate and set aside for now. It will be reused when the motor assembly is reinstalled into the case (Figure 9-25).

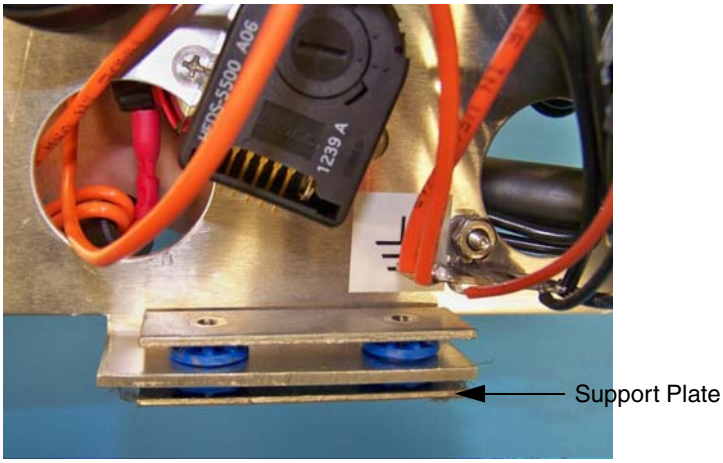


Figure 9-25 Support plate

Note

Make a note of the position of the two orange and two black wires connected to the motors. Marking them “Top” and “Bottom” may help keep them straight during assembly.

Figure 9-26 Position of wires connected to the motors

9. The wire connections from the motors to the terminal strips are shown in Figure 9-27.

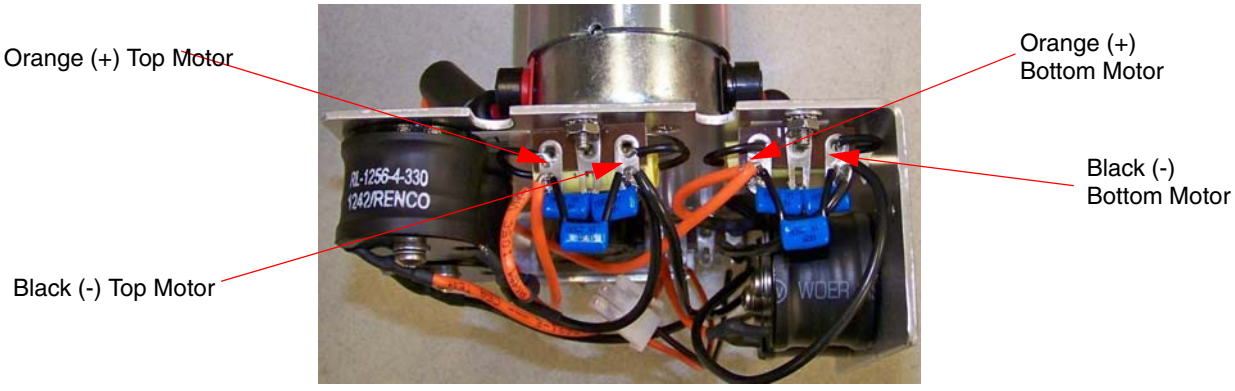


Figure 9-27 Wire connections

10. Leaving the wires connected to the terminals, use a flat-blade screwdriver and remove the set screws holding the two **Negative (-)** brushes (black wires) into the motors.

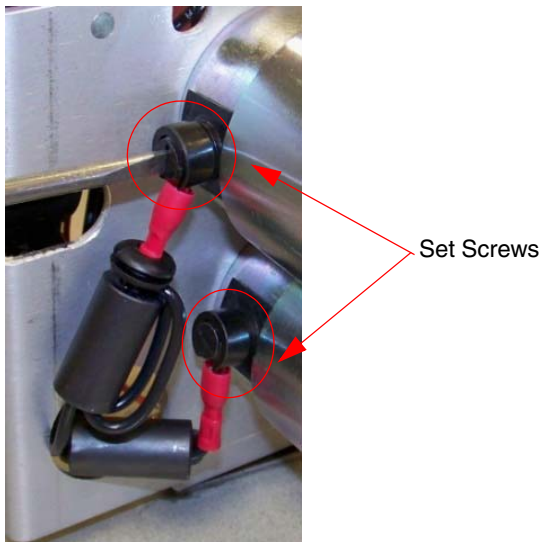


Figure 9-28 Set screws holding the two negative brushes

11. Grasp the connector on one of the black wires and wiggle the connector to loosen the brush. Gently pull the brush out of the motor. Once out, disconnect wire from brush contact. Repeat this process for the second black wire being sure not to get the wires mixed up.

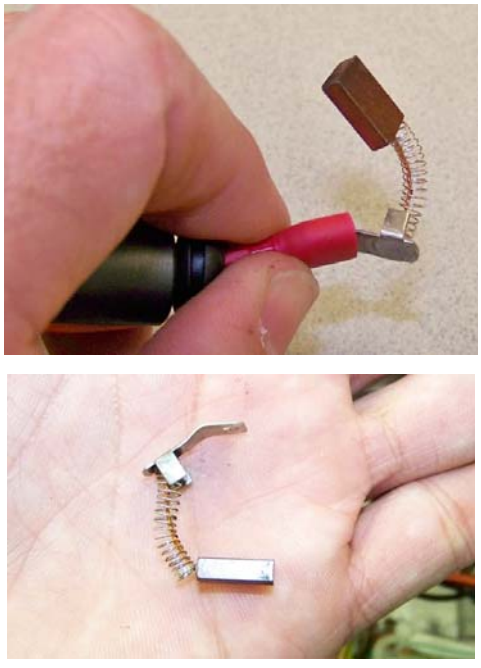


Figure 9-29 Wires disconnected from brush contact

12. Connect the bottom black wire to the new brush and insert the new brush into the motor using the connector as leverage to guide brush into the motor. Hold the connector so the brush is fully engaged into the motor (Figure 9-30)then reinstall the set screw that holds brush in place. Repeat this process for the top black wire.

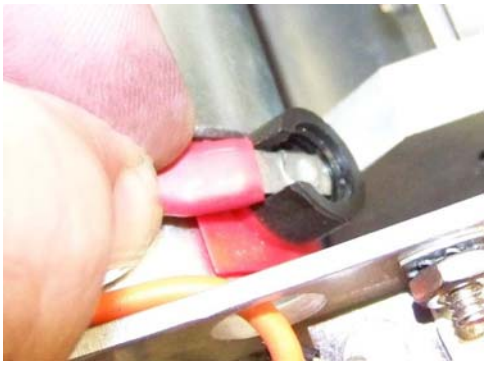


Figure 9-30 Connector connected to the brush

13. Leaving the wires connected to the terminals, use a flat-blade screwdriver and remove the set screws holding the two **Positve (+)** brushes (orange wires) into the motors.

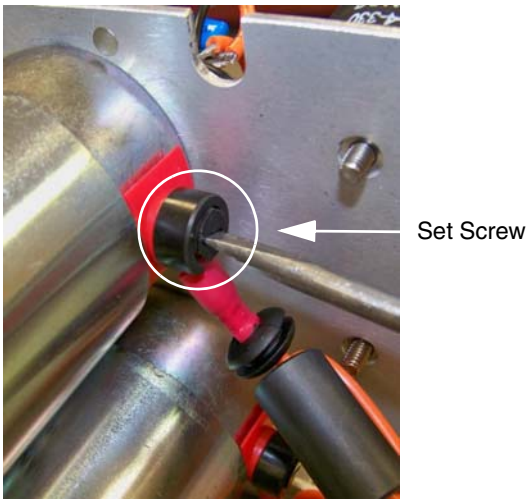


Figure 9-31 Removing the set screws

14. Grasp the connector on one of the orange wires and wiggle the connector to loosen the brush, then gently pull the brush out of the motor. Once out, disconnect wire from brush. Repeat this process for the second orange wire.

Figure 9-32 Loosen the connector

15. Connect the bottom orange wire to the new brush and insert the new brush into the motor using the connector as leverage to guide brush into the motor. Hold the connector so the brush is fully engaged into the motor (Figure 9-33) then reinstall the set screw that holds brush in place. Repeat this process for the top orange wire.

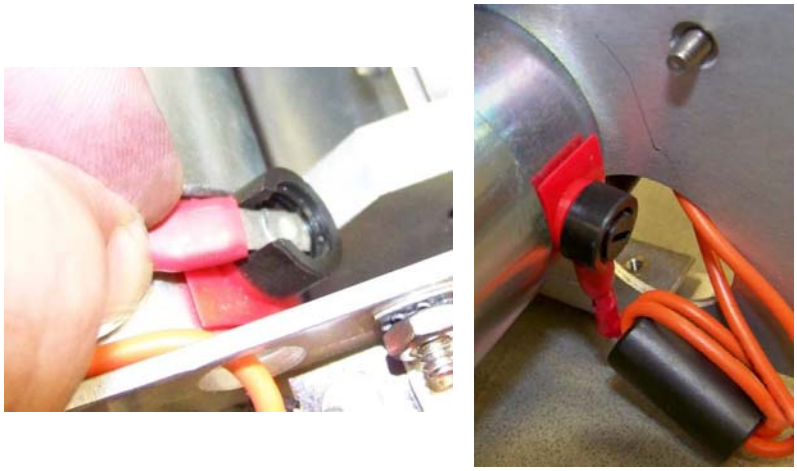


Figure 9-33 New brush reinstalled; set screw replaced

Reassembly of Motor Brush

1. Install the small support plate on the bottom of the blue motor mounts so the adhesive side is against the rubber mounts (Figure 9-25).
2. Carefully slide the motor assembly back into the case so the motor gears mesh with the brown gear in the bearing plate and the motor plate fits over the two locating pins. It may be necessary to spin the motor gears to get the teeth to align with the brown gear. Do not force the gears to fit or damage to the gear teeth may occur.

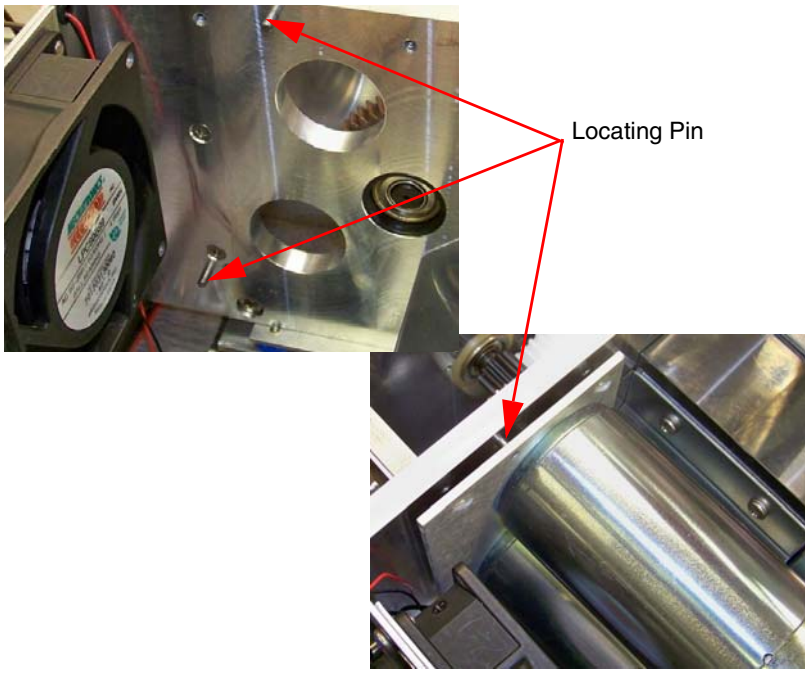


Figure 9-34 Location of locating pins

3. Once the motor plate is located properly over the two locating pins install the three screws and three flat washers to hold motor in place and tighten the screws (Figure 9-23).
4. At this time verify that the small flat support plate is still in place under the motor assembly and is aligned with the holes in the motor mounts (Figure 9-25).
5. Lay the pump on its side and align the flat support plate with the two holes in the bottom of the case, then install the two screws with two lock washers into the bottom of the motor plate and tighten screws. (Figure 9-20, top middle screws).
6. While the pump is still on its side align the circuit board assembly so the three mounting holes in the bottom of the case line up with the three mounting holes on the circuit board assembly and install the three screws with three lock washers, but do not tighten at this time (Figure 9-20).
7. Set the pump upright and check the following:

- Check that there are no pinched wires under the circuit board assembly.
- Check that the ferrite beads are not pinched between the motors and the fan.
- Check that the ferrite beads are not pinched between the motor plate and the bearing plate.

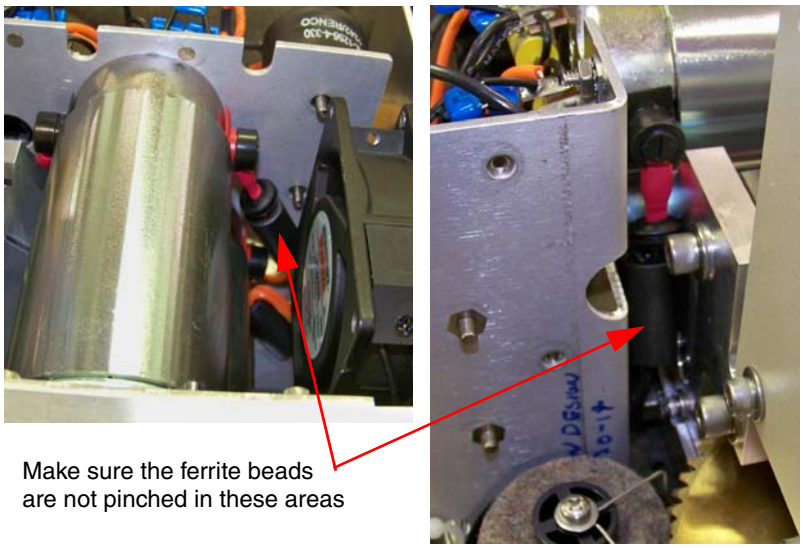


Figure 9-35 Motor plate and bearing plate

8. Once it has been determined that all wires are clear of being pinched, lay the pump back on its side and fully tighten the three screws to secure the circuit board assembly to the case (Figure 9-20).
9. Set the pump upright and install the deflector shield so the tab lies flat against the bearing block, then install the two screws and two flat washers.

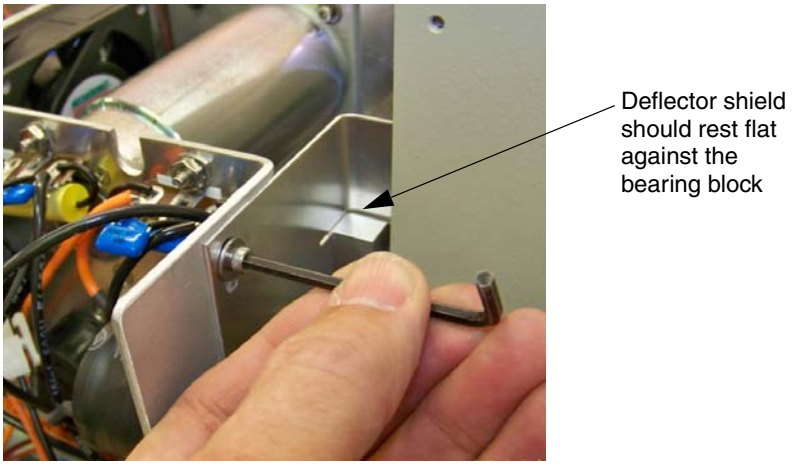


Figure 9-36 Installing the deflector shield

10. Plug in the connector to the encoder being careful not to bend any pins (Figure 9-22).
11. Carefully plug in the 2-pin connector for the motor assembly then secure the wires within the nylon twist-tie attached to the bottom of the case (Figure 9-21).
12. Check that the capacitor right above the motor shaft is not in contact with the motor shaft. If the capacitor is rubbing

on the shaft carefully pry up on the capacitor until it no longer makes contact.

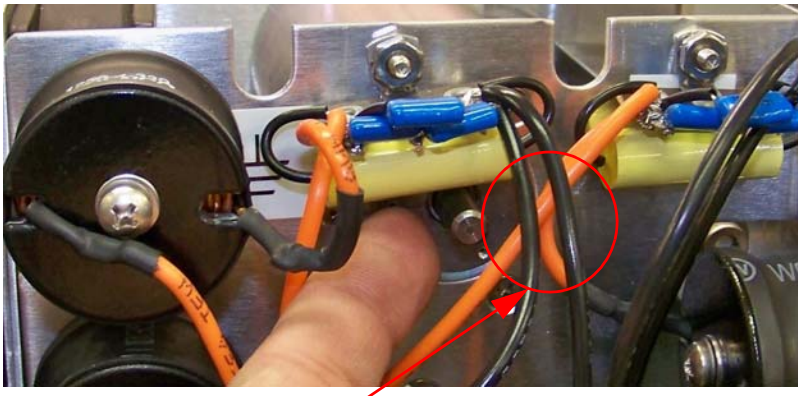


Figure 9-37 Capacitor and motor shaft

9.14 Calibrations

It should not be necessary to readjust the instrument unless repairs have been made on the electronic circuitry or the controller cable length has been changed.

9.14.1 Pressure Transducer Calibration

Note

Please contact the factory if your pressure transducer requires recalibration.

9.14.2 A/D Circuit Adjustment

This adjustment is done in the controller unit.

1. With the controller operating and pumps not running, press MENU, MORE, MORE, 2, 3, to display the A/D Calibration screen.
2. Adjust R109 (REF) to obtain a voltage of 2.5000 VDC ±0.0001 at TP18 (REF) with respect to TP28 (A GND).
3. Connect a jumper between TP25 (ANLG2) and TP28 (A GND).
4. Connect a jumper between TP21 (ANLG1) and TP18 (REF).
5. Adjust R86 (GAIN) until the GAIN display reads 2.5000 ±0.0001.
6. Adjust R10 (OFFSET) until the OFFSET display reads 0.0000 ±0.0001.
7. Repeat steps 5 and 6 until both readings are within ±0.0001.
8. Remove the jumpers.

9.14.3 Limit Sensor Adjustment

In the event that the limit sensors must be replaced on the pump, use the following procedure:

1. Disconnect the instrument from mains power.
2. Disconnect the pressure transducer cable from the pump, and remove the tubing from the inlet and outlet ports.
3. Loosen the four cover screws and remove the front and rear covers of the pump.
4. The cylinder must be unscrewed several turns to avoid accidentally bottoming the piston out during calibration of the limit sensor. Therefore, loosen the cylinder lock screw. The lock screw is located in the front side of the cylinder mounting block and is a ¼-20 setscrew.
5. The limit sensor assembly includes two limit sensors, the wire harness and connector, and a conduit which protects the wires running between the sensors, Figure 9-38.

   Depending upon when your pump was manufactured, the protective conduit may be directly fastened to the pump or retained with mounting tabs and cable ties.

   If the conduit is fastened directly to the case, then it must be removed and the plastic mounting tabs included with the limit sensor assembly package should be installed using the existing screws and screw holes.

To install the mounting tabs

   a. Remove the screws and the conduit.

   b. Then use the same screws and holes to install the mounts. Be sure the tab portion of the mount is facing away from the sensors, as shown in Figure 9-39, (the screw aperture is closest to the sensors).

   If your pump already has the plastic tabs installed, cut and discard the plastic cable ties which run through the tabs and hold the conduit.

6. Remove the four screws holding the limit sensors, and unplug the cable from the power circuit board. (The replacement limit sensor assembly includes both the upper and lower sensor and the plug.)

☑ Note

There are several additional cable ties along the path from the limit sensors to the power board. Two are reusable twist ties and (usually 3) others need to be cut to free the limit sensor wires. These cable ties must be replaced to prevent the wires from entangling with the worm gear.

7. Install the new limit sensor harness; and secure the protective conduit by running the cable ties through the mounts and tightening. Then cut the excess cable tie and discard.

☑ Note

Be sure the circuit board connector is mated pin-for-pin with the jack.

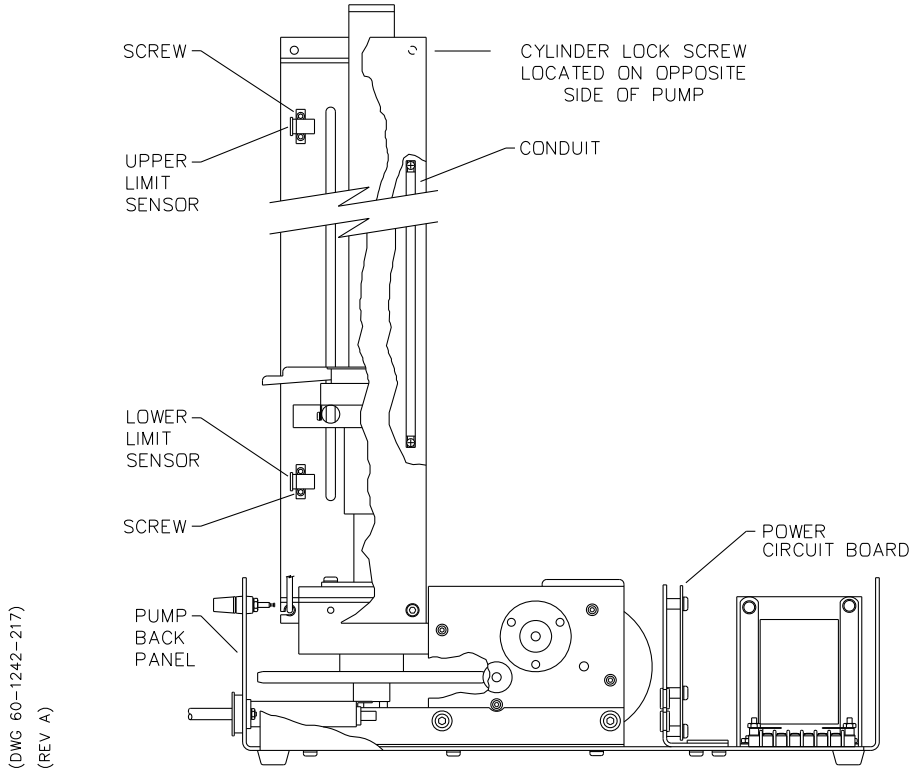


Figure 9-38 Limit sensor replacement

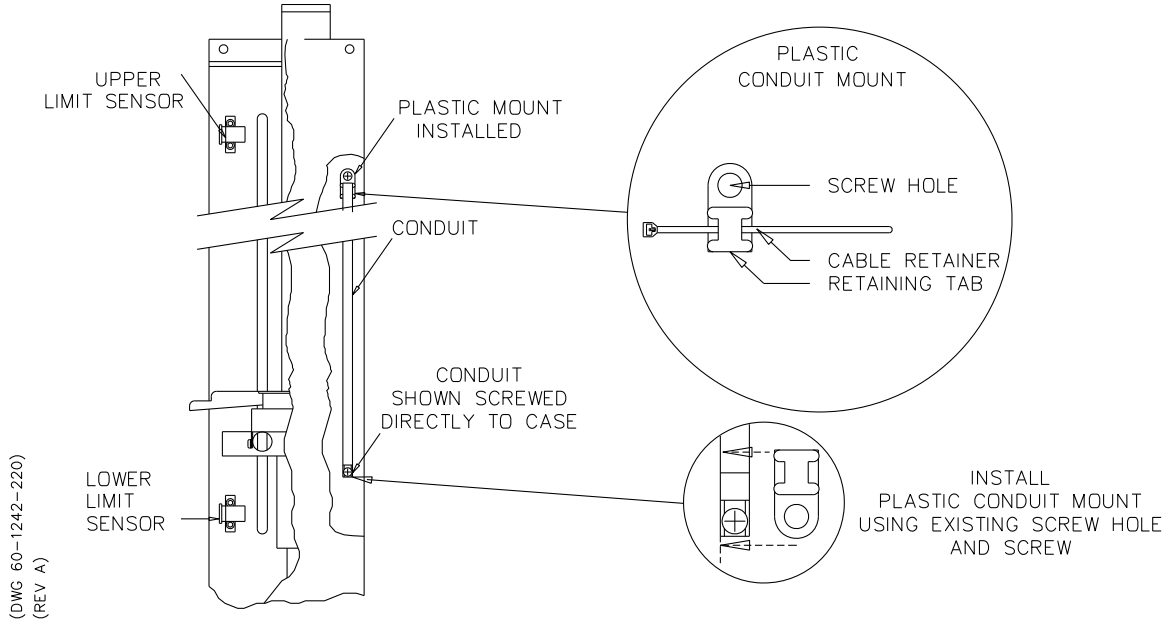


Figure 9-39 Installing the plastic mounts

8. (Not 30D) Be sure that the cylinder is unscrewed several turns. If you need to use a wrench, we recommend a strap wrench or wrenches in the Teledyne Isco wrench package (P/N 68-1247-067 for 100DM, 100DX, an d 260D; P/N 68-1247-068 for 500D; P/N 60-1247-093 for 1000D; or 60-1247-130 for 65D and 65DM) which will not mar the cylinder's outer surface.
   a. For the 30D, the cylinder cap is removed, and the pump is run to its extreme. The clearance between the piston top surface and the top of the cylinder needs to be adjusted to .025"-.050" (0.6-1.3 mm) with the cylinder cap seal removed.
9. Center the pump bottom limit sensor with respect to the mounting screws and tighten them.
10. Raise the top limit sensor to the extent of the slots and tighten the upper screw.

Now the new limit sensors MUST be calibrated, as explained in the following section.

9.14.4 Limit Sensor Calibration (Excludes 30D)

Once the new limit sensor assembly is installed, the sensors must be calibrated. Before calibrating the limit sensors, be sure the cylinder is unscrewed several turns. Follow steps 8-10 in the previous section (9.14.3). Use the following procedure to calibrate the limit sensors:

1. Connect the pressure cable and power cord and turn the controller ON.
2. Press REFILL and enter the maximum rate.
3. Press STOP when the interrupter flag is approximately ¼" from the full (lower) sensor.
4. Press 'A' (FLOW RATE), and use the number key to set 10 (ml/min). Press the ENTER key.
5. Press REFILL.
   After the lower limit sensor is interrupted, the motor will stop.
6. Press CONST FLOW.
7. Press 'A' (FLOW RATE) and select MAX.
8. Press RUN.
9. Press STOP when the volume counter in the upper right-hand corner of the LCD reads 005.00 ml or less.
10. Press 'A' (FLOW RATE) and enter 5 ml/min.
11. Press RUN .
12. Press STOP when the counter reads 000.30 or less.
13. Press 'A' (FLOW RATE) and enter 1 ml/min.
14. Press RUN.
15. When the counter counts from 000.01 to 000.00, press STOP.
16. Lower the upper limit sensor to the point where the flag just interrupts the sensor. ("CYLINDER EMPTY" will flash on the screen.)
17. Tighten the top upper limit mounting screw.
18. Turn the controller to STANDBY and disconnect the pressure cable.
19. Screw the cylinder into the cylinder mounting block until the cylinder bottoms firmly against the stop ring in the cylinder mounting block (the cylinder will no longer turn). **Do not overtighten.**
20. Unscrew the cylinder a minimum of ½ turn, then line up the inlet and outlet ports as you had them before. Do not unscrew the cylinder more than one full turn from the stop position.
21. Lock the cylinder by tightening the locking screw.
22. Connect the pressure cable and power cord and turn the controller ON.
23. Press REFILL. Wait until you have access to the second upper limit sensor mounting screw and tighten it.

24. Install the covers.

9.14.5 30D Limit Sensor Calibration

The following steps are for the 30D limit sensor calibration:

1. Disconnect the mains power and the transducer cable from the cylinder cap.
2. Remove the cylinder cap and the cylinder cap seal.
3. Reattach the transducer cable to the cylinder cap and set out of the way.
4. Attach a controller to the pump and reconnect the mains power.
5. Turn the pump and controller on.
6. Turn off AUTO-REFILL if it is turned on.
7. Press REFILL and enter the maximum flow rate.
8. Press STOP when the interrupter flag is about $^1/_4$" (6mm) from the lower sensor.
9. Press 'A' (FLOW RATE) and use the number keys to change the refill flow rate to 10 mL/min. Press the ENTER key.
10. Press REFILL. When the lower limit sensor is interrupted, the motor will stop.
11. Press CONST FLOW.
12. Press 'A' (FLOW RATE)) and select MAX.
13. Loosen the lower screw on the upper limit sensor about one turn. Do not remove the screw.
14. Press RUN.
15. Press STOP when the volume counter in the upper right-hand corner of the LCD reads 005.00 mL or less.
16. Press 'A' (FLOW RATE) and enter 5 mL/min.
17. Press RUN.
18. When the counter changes from 000.01 to 000.00, press STOP.
19. Lower the upper limit sensor to the point where the flag just interrupts the sensor. (CYLINDER EMPTY will flash on the screen.)
20. Tighten the upper limit upper mounting screw.
21. Press REFILL on the controller to lower the piston until the lower screw in the upper limit sensor is exposed and then tighten the upper limit screw.
22. Press RUN.
23. The pump will stop when the upper limit sensor is interrupted.
24. Lay a straight edge across the top of the cylinder and measure the clearance between the piston and the top of the cylinder.

25. If the clearance is not between 0.025" and 0.050" (0.6-1.3 mm), loosen the screw holding the interrupter and move the interrupter SLIGHTLY. Repeat steps 22-25.
26. Set both the REFILL and FLOW RATE to MAX.
27. Press REFILL and allow the pump to interrupt the lower sensor. The pump will stop.
28. Press RUN and allow the pump to interrupt the upper sensor. The pump will stop.
29. Lay a straight edge across the top of the cylinder, and measure the clearance. If the clearance is not within range, repeat steps 22-30.
30. Turn off the pump and controller.
31. Disconnect the mains power.
32. Detach the cable from the transducer.
33. Install a cylinder cap seal. If the cylinder cap seal is being reused, inspect the seal for cracks, damage, or excessive deformation (slight flaring of the top edge is acceptable).
34. Apply a small amount of Never-Seez® lubricant to the first few threads of the cylinder.
35. Install the cylinder cap.

⚠ WARNING

Use proper tools to hold the cylinder while installing the cylinder cap. Installing the cap without holding the cylinder can damage the pump.

36. Torque the cylinder cap to 50 ft-lbs (68 N-m).
37. Reattach the transducer cable.

9.14.6 Electric Valve Motor Calibration

If a motor is replaced on the electric valve assembly, it must be calibrated before use, in order to obtain optimum closure force. Remove the top covers from both the controller and the electric valve assembly.

⚠ WARNING

The instrument must be powered on during this procedure; use extreme caution while servicing.

1. Note the voltage value written on the side of the newly installed motor.

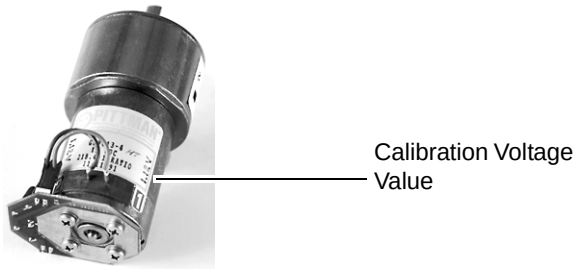


Figure 9-40 Electric valve motor voltage

2. Inside the controller, attach the leads of a voltmeter across resistor **R204** on the electric valve interface board.
3. Press ACC CTRL (ACC CTRL) > PRGM GRAD (PRGM GRAD).
4. Press the number key that corresponds with the new motor. This opens the valve.
5. Press the corresponding number key again to close the valve; the motor will continue to apply torque to the valve for approximately 30 seconds.
6. On the electric valve assembly CBA, adjust the corresponding potentiometer to the voltage printed on the side of the motor (refer to Figure 9-41).

> ☑ ***Note***
>
> This procedure must be done during the 30 seconds that the motor is applying torque and the valve is in its closed position. The valve may have to be opened and closed more than once to complete this procedure.

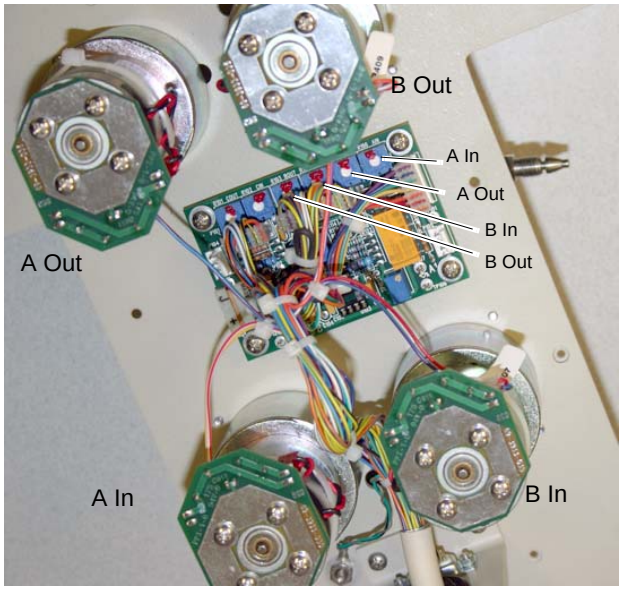


Figure 9-41 Electric valve motor adjustment

D Series Syringe Pumps

Appendix A Replacement Parts

A.1 Replacement Parts

Replacement parts are called out in the following illustrations. Refer to the call-out in the adjacent table to determine the part number for the item.

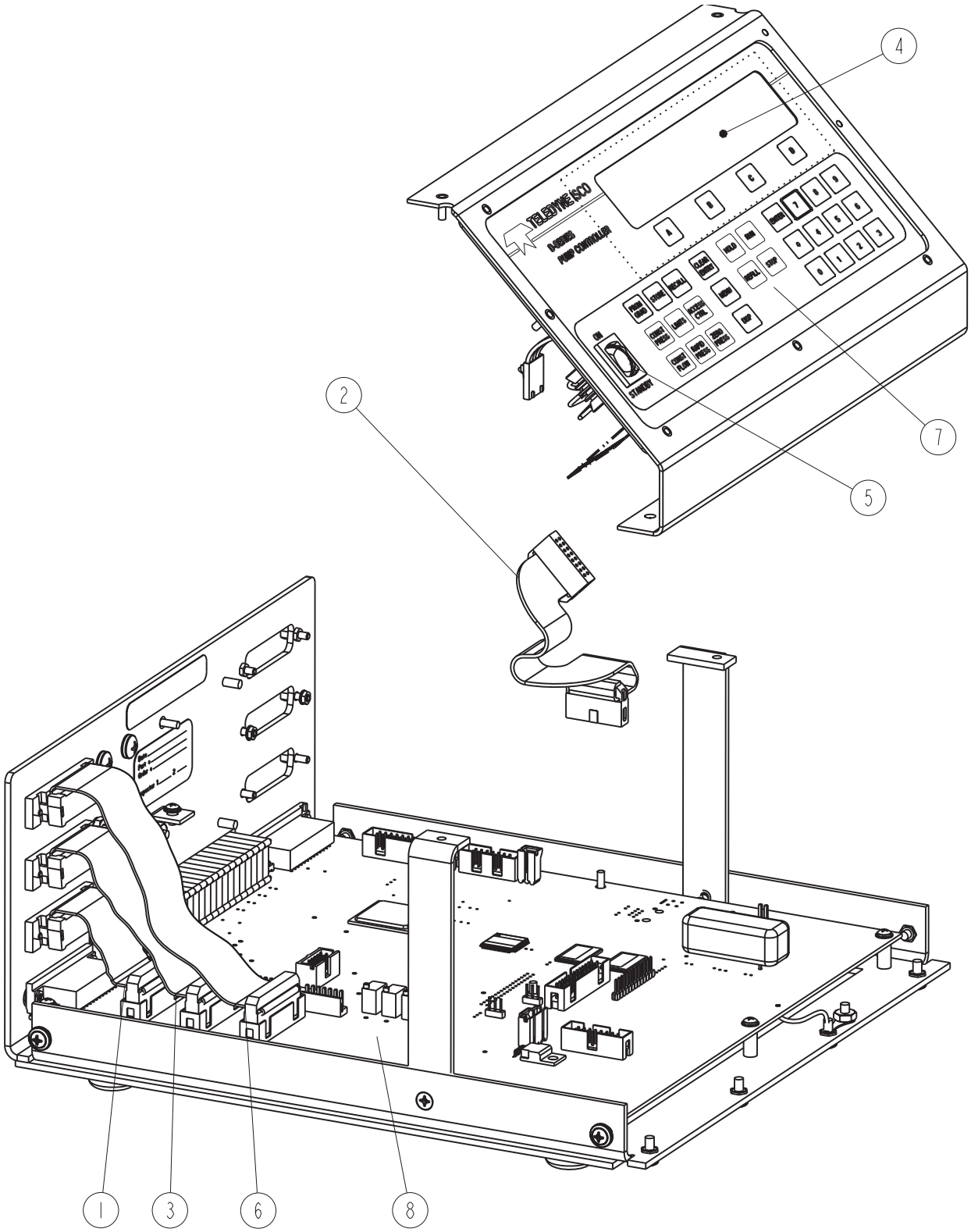
Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

Teledyne Isco
Customer Service Department
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail: IscoInfo@teledyne.com

A.1.1 D Series Controller



601242981

SHEET: 2 OF 2

REV: A

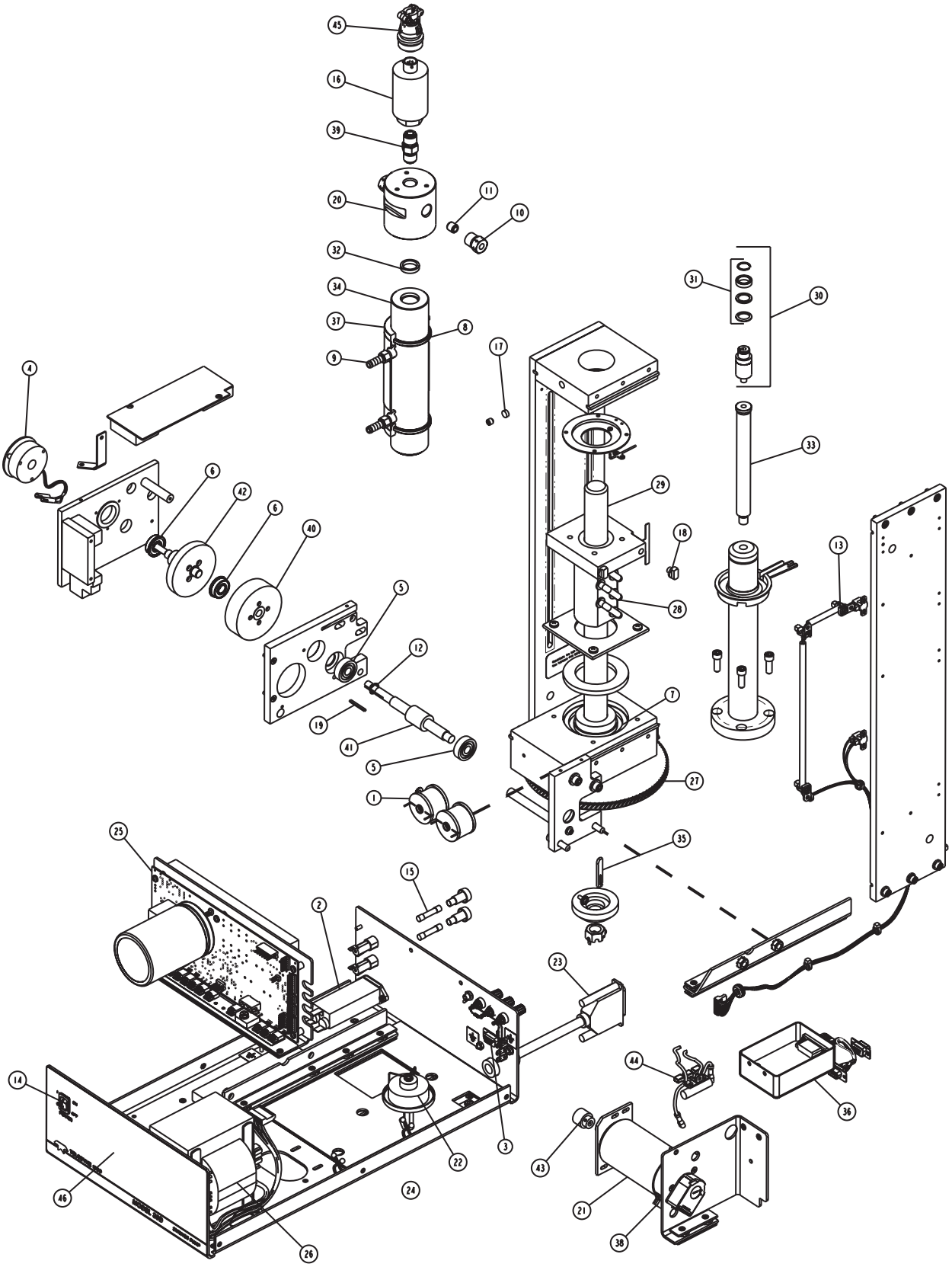
REPLACEMENT PARTS LIST

TELEDYNE ISCO

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-230	CABLE ASSEMBLY
2	60-1244-231	CABLE ASSEMBLY
3	60-1244-232	CABLE ASSEMBLY
4	60-1244-410	DISPLAY ASSEMBLY
5	60-1244-477	SWITCH ASSEMBLY
6	60-3934-015	CABLE ASSEMBLY
7	60-1248-211	FRONT LABEL AND MOUNTING PLATE
8	60-1247-173	REPLACEMENT KIT,CBA,CONTROLLER
8	60-1247-174	REPLACEMENT KIT,CBA 4-20,CONTROLLER
8	60-1247-185	REPLACEMENT KIT,CBA,CONTROLLER,30D

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

A.1.2 30D Pump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601262101

REPLACEMENT PARTS LIST

SHEET: 2 OF 3

TELEDYNE ISCO

REV: E

ITEM NO.	PART NUMER	DESCRIPTION
1	120000701	CHOKE
2	120001300	EMI POWER FILTER
3	141400102	SKT D-SUB 9 CONT
4	150000601	BRK FLSF RVS 24V KB
5	201032900	BRG CYL.354ID1.00D KB
6	201133700	BRG CYL .38ID.880D KB
7	201429902	BRG THR 351DX720D, INDIVIDUAL (ORDER QTY: 2)
8	202206223	O RING 1.609ID.139
9	209016100	CONN MALE .12 HOSE
10	209016402	GLAND F250C 30VM
11	209016403	CLR F250C 30VM
12	233613600	WSHR WV .397 ID
13	691244415	UNIVERSAL SENSOR HARNESS
14	410730401	SW RKR DPDT CSA 4A KB
15	411461264	FU 1.6A 250 SB 3AB (234 VOLT)
15	411461271	FU 3.2A 250 SB 3AB (100 VOLT & 117 VOLT)
16	460010119	XDCR PRESS 0-30,000 PSI
17	601243291	DELRIN PLUG
18	601243348	SLIDE THRUST BEARING
19	601243610	GEAR TRAIN KEY
20	601243876	CYLINDER CAP, 65ML
21	601244184	MOTOR ASSEMBLY
22	601244236	LUBE WHEEL ASSEMBLY
23	601244323	HARN MN PMP - ENCD KB
24	601243981	GEAR TRAIN SOAK PAD
25	601249130	30D CBA REPLACEMENT KIT
26	601244493	XFRMR ASSY,30D
27	601245168	WORM GEAR MOD
28	601248116	BALL NUT ASSY
29	601248127	BALL SCREW ASSY
30	601249128	RPLCMNT KIT,30D PISTON ASSY
31	601249129	RPLCMNT KIT,30D PISTON SEAL
32	601263098	CYLINDER CAP SEAL, 30ML
33	601263144	PUSH ROD, 30ML
34	601263105	CYLINDER,30ML

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

601262101

REPLACEMENT PARTS LIST

SHEET: 3 OF 3

TELEDYNE ISCO

REV: E

ITEM NO.	PART NUMER	DESCRIPTION
35	601263131	SHEAR KEY,30D
36	601264082	ASSY,30D PRESS AMP
37	601267010	COOLING JACKET,ASSY,30D
38	602254132	MOTOR BRUSHES (PKG 2)
39	605363068	DUAL MALE F250C ADPTR KB
40	691243560	SPUR GEAR
41	691243563	EXTENDED WORM GEAR
42	691243800	COMBINATION GEAR
43	691243802	PINION GEAR
44	691264154	REPLACEMENT TERMINAL STRIP ASSY
45	691244413	TRANSDUCER CABLE ASSEMBLY
46	691263096	LABEL,FRNT PNL,30D PMP

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

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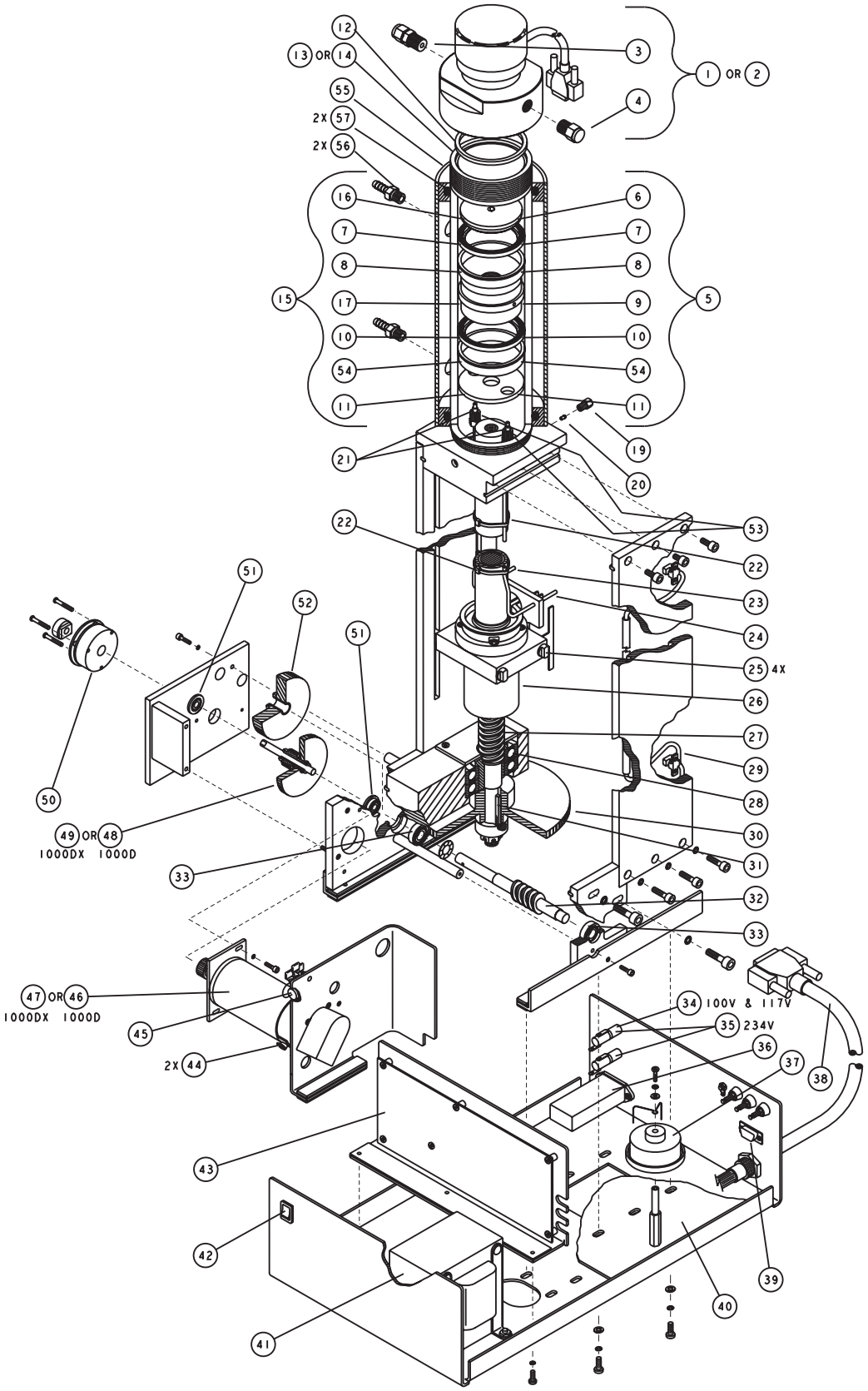
A.1.3 1000D Pump



REPLACEMENT PARTS LIST

DWG. NO.: 60-1242-347
SHEET: 2 OF 3
REV.: H DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-334	PREAMP ASSY, NITRONIC
2	60-1244-335	PREAMP ASSY, HASTELLOY
3	209-0163-36	CONNECTOR, 1/4 TO 1/4 NPT, 316 STAINLESS STEEL
4	209-0168-09	PIPE PLUG, 1/4 NPT, 316 STAINLESS STEEL
5	60-1244-326	1000ml PISTON ASSY, NITRONIC
6	60-1243-772	1000ml SEAL RETAINER, NITRONIC
7	202-9990-25	UPPER SEAL
8	60-1243-776	WEAR RING
9	60-1243-803	PISTON BODY, NITRONIC
10	202-9990-23	LOWER SEAL
11	60-1243-721	PISTON BASE, NITRONIC
12	69-1243-779	1000ml CYLINDER CAP SEAL
13	69-1243-780	1000ml CYLINDER, NITRONIC
14	69-1243-793	1000ml CYLINDER, HASTELLOY
15	60-1244-331	1000ml PISTON ASSY, HASTELLOY
16	60-1243-792	1000ml SEAL RETAINER, HASTELLOY
17	60-1243-794	PISTON BODY, HASTELLOY
19	209-0169-35	GLAND NUT, 1/16 ID
20	209-0169-34	FERRULE, 1/16 ID
21	209-0169-46	FERRULE, 1/8 ID
22	489-0100-01	CABLE TIE, TEFZEL
23	60-1243-774	RIGHT WASH TUBE
24	60-1243-773	LEFT WASH TUBE
25	60-1243-348	THRUST BEARING
26	60-1248-116	BALL NUT ASSY
27	60-1248-117	BALL SCREW ASSY
28	201-4299-02	THRUST BEARING (INDIVIDUAL, ORDER 2 EA)
29	69-1244-415	UNIVERSAL SENSOR HARNESS
30	69-1243-431	WORM GEAR
31	60-1243-607	KEY
32	69-1243-563	EXTENDED WORM GEAR
33	201-0329-00	BEARING

NOTE: 1. This list is subject to change without notice.

REPLACEMENT PARTS LIST

DWG. NO.: 60-1242-347
SHEET: 3 OF 3
REV.: H DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
34	411-0311-62	FUSE, 2 AMP "T"
35	411-0311-51	FUSE, 1 AMP "T"
36	120-0013-00	POWER FILTER, 6A
37	60-1244-236	LUBE WHEEL ASSY
38	60-1244-323	MAIN HARNESS
39	141-4001-02	SUB-D SOCKET
40	60-1243-492	SOAK PAD
41	60-1244-309	TRANSFORMER ASSY
42	410-7304-01	ROCKER SWITCH, DPDT, 4 AMP, CSA
43	60-1245-162	POWER DRIVE CBA, DIGITALLY ENCODED, 1000D
44	60-2254-132	MOTOR BRUSHES
45	113-3250-00	CAPACITOR, 5 f, 100VDC
46	60-1244-184	MOTOR ASSY FOR 1000D PUMP
47	60-1244-329	MOTOR ASSY FOR 1000DX PUMP
48	69-1243-800	COMBINATION GEAR FOR 1000D PUMP
49	69-1243-805	COMBINATION GEAR FOR 1000DX PUMP
50	150-0006-01	BRAKE
51	201-1337-00	BEARING CYLINDER
52	69-1243-560	GEAR
53	209-0169-44	GLAND NUT, 1/8 IB
54	60-1243-809	LOWER WEAR RING
55	60-1248-183	COOLING JACKET ASSY 1000D
56	209-0161-00	MALE HOSE CONNECTOR
57	202-2062-35	O-RING, 3.109 ID, .139 CROSS SECTION

NOTE: 1. This list is subject to change without notice.

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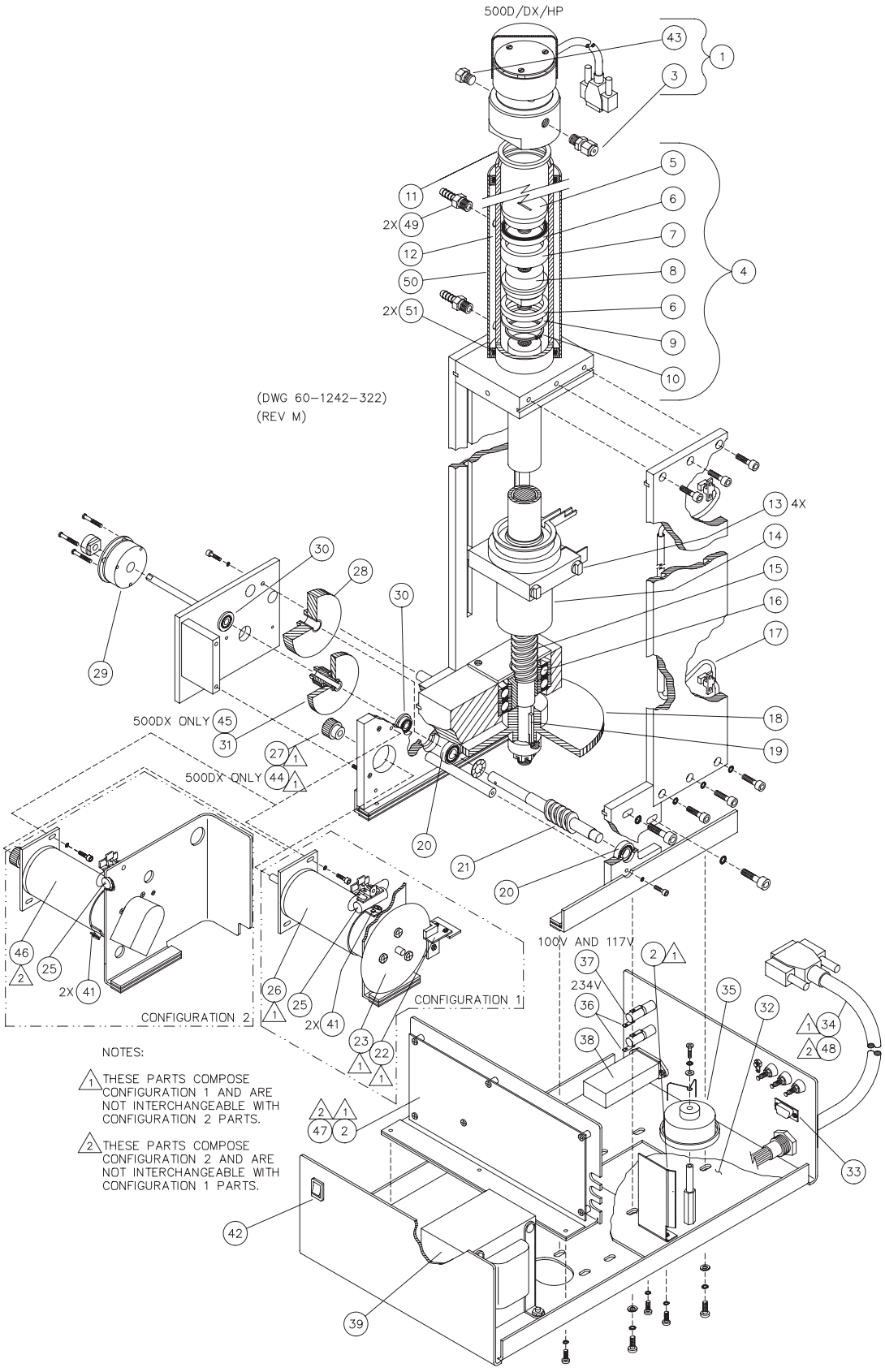
A.1.4 500D/DX Pump



REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-322
SHEET: 2 OF 3
REV.: N DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-239	PREAMP ASSY (NITRONIC)
1	60-1244-451	PREAMP ASSY (HASTELLOY)
3	209-0161-01	MALE CONNECTOR (STAINLESS STEEL)
3	209-0168-16	MALE CONNECTOR (HASTELLOY)
4	60-1244-221	500ML PISTON ASSY (NITRONIC)
4	60-1244-319	500ML PISTON ASSY (HASTELLOY)
5	60-1243-454	500ML SEAL RETAINER (NITRONIC)
5	69-1243-759	500ML SEAL RETAINER (HASTELLOY)
6	202-9091-56	SEAL
7	60-1243-538	WEAR RING
8	60-1243-535	PISTON BASE (NITRONIC)
8	69-1243-758	PISTON BASE (HASTELLOY)
9	60-1243-185	500ML WIPER RETAINER
10	209-0011-37	RETAINING RING
11	69-1243-455	500ML CYLINDER CAP SEAL
12	69-1243-577	500ML CYLINDER (NITRONIC)
12	69-1243-751	500ML CYLINDER (HASTELLOY)
13	60-1243-348	THRUST BEARING
14	60-1248-116	BALL NUT ASSY
15	60-1248-117	BALL SCREW ASSY
16	201-4299-02	THRUST BEARING (INDIVIDUAL, ORDER 2 EA)
17	69-1244-415	UNIVERSAL SENSOR HARNESS
18	69-1243-431	WORM GEAR
19	60-1243-654	KEY
19	60-1243-607	SHEAR KEY (FOR 500HP ONLY)
20	201-0329-00	BEARING (SEE NOTE 3 AT BOTTOM OF PAGE)
21	69-1243-563	EXTENDED WORM GEAR
25	113-3250-00	CAP 5uF 100VDC
28	69-1243-560	SPUR GEAR
29	150-0006-01	BRAKE
30	201-1337-00	BEARING (SEE NOTE 3 AT BOTTOM OF PAGE)

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-322
SHEET: 3 OF 3
REV.: N DATE: 073109

ITEM NO.	PART NUMBER	DESCRIPTION
	*CONFIGURATION 1	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 2 PARTS)*
2	60-1244-260	POWER DRIVE CBA
22	69-1244-924	CBA TACH SENSOR
23	60-2255-029	TACH DISK
26	69-1243-562	MOTOR
27	69-1243-802	PINION GEAR
31	69-1243-800	COMBINATION GEAR
32	60-1243-492	SOAK PAD
33	141-4001-02	D-SUB SOCKET
34	60-1244-193	MAIN HARNESS
35	60-1244-236	LUBE WHEEL ASSY
36	411-0311-51	FUSE 1 AMP "T"
37	411-0311-62	FUSE 2 AMP "T"
38	120-0013-00	POWER FILTER 6A
39	60-1244-309	TRANSFORMER ASSY
40	60-1244-220	GEAR LUBRICATION ASSY (NOT SHOWN)
41	60-2254-132	MOTOR BRUSHES
42	410-7304-01	SW DPDT ROCKER CSA 4A
43	209-0168-05	PIPE PLUG (STAINLESS STEEL)
43	209-0165-78	PIPE PLUG (HASTELLOY)
44	69-1243-717	24T, 24P PINION GEAR
45	69-1243-718	COMBINATION GEAR
49	209-0161-00	MALE HOSE CONNECTOR
50	60-1248-099	COOLING JACKET ASSY 500ML
51	202-2062-11	O-RING, 2.109 ID, .139 CROSS SECTION
	*CONFIGURATION 2	PARTS (NOT INTERCHANGEABLE WITH CONFIGURATION 1 PARTS)*
46	60-1244-444	MOTOR MOUNT ASSEMBLY
47	60-1245-161	CBA SYRINGE PUMP DRIVE UNITS, 500D
47	60-1245-176	CBA MOTOR DRIVE (FOR 500HP ONLY)
48	60-1244-323	MAIN HARNESS

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

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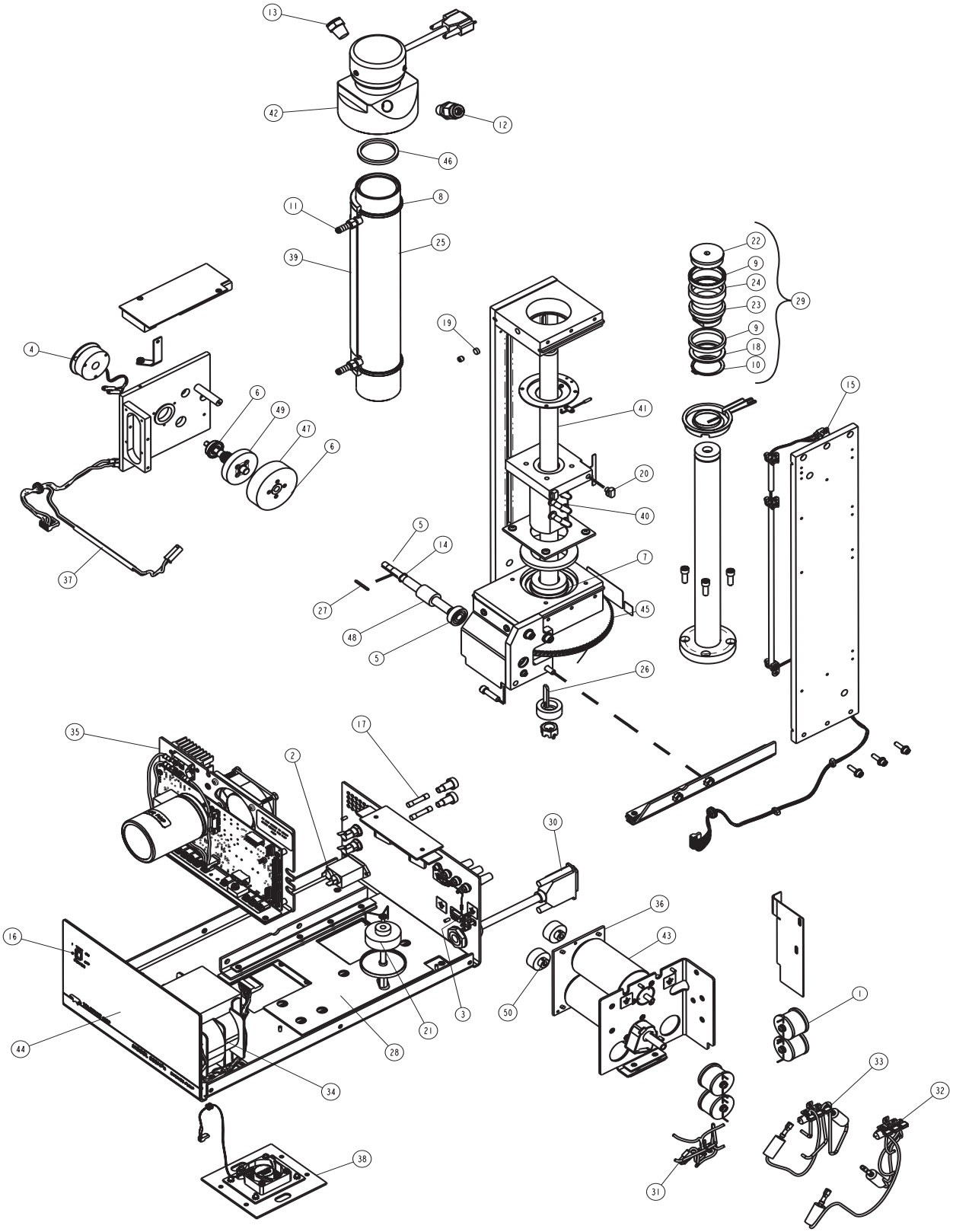
A.1.5 500HPx Pump



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REPLACEMENT PARTS LIST

SHEET: 2 OF 3

REV:

TELEDYNE ISCO

ITEM NO.	PART NUMER	DESCRIPTION
1	120000701	IDCTR 330 UH 11.0A
2	120001201	FLTR 10 AMP PWR
3	141100102	SUB-D SOCKET
4	150000601	BRK FLSF RVS 24V
5	201032900	BRG CYL.3541D1.0OD
6	201133700	BRG CYL .381D.880D
7	201429902	BRG THR 351DX720D, INDIVIDUAL (ORDER 2 EACH)
8	202206211	O-RING 2.111D .139
9	202909156	SEAL,1.5631DX1.81OD
10	209001137	RTNG RING EXT 1.37
11	209016100	CONN MALE .12 HOSE
12	209016583	FTG TUBE 3/8 OD X 3/8 MALE NPT (NITRONIC)
12	209016561	FTG TUBE 3/8 OD X 3/8 MALE NPT (HASTELLOY)
13	209016813	PLUG PIPE 3/8 NPT (NITRONIC)
13	209016914	PLUG PIPE 3/8" NPT (HASTELLOY)
14	233613600	WSHR WV .397 ID
15	319000384	SNSR OPB840W11 24"
16	410730401	SW RKR DPDT CSA 4A
17	411031274	FU 6.25A 250 SB 3AG (117 VOLT)
17	411461271	FU 3.2A 250 SB (234 VOLT)
17	411091272	FU 7.5A 250 SB (100 VOLT)
18	601243185	RTNR WIPER 500ML KB
19	601243291	P DLRN KB
20	601243348	SLIDE THRUST BEARING
21	601244236	WHL LUBE ASSY
22	601243454	RTNR SEAL 500 ML KB (NITRONIC)
22	691243759	RTNR SEAL 500 ML KB (HASTELLOY)
23	601243535	BASE PSTN 500 ML KB (NITRONIC)
23	691243758	BASE PSTN 500 ML KB (HASTELLOY)
24	601243538	R WEAR 500 ML KB
25	601243577	CYLINDER 500ML (NITRONIC)
25	69124375I	CYLINDER 500ML (HASTELLOY)
26	601243607	SHEAR KEY
27	601243610	KEY GRTN
28	601243981	GEAR TRAIN SOAK PAD

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

601242968

REPLACEMENT PARTS LIST

SHEET: 3 OF 3

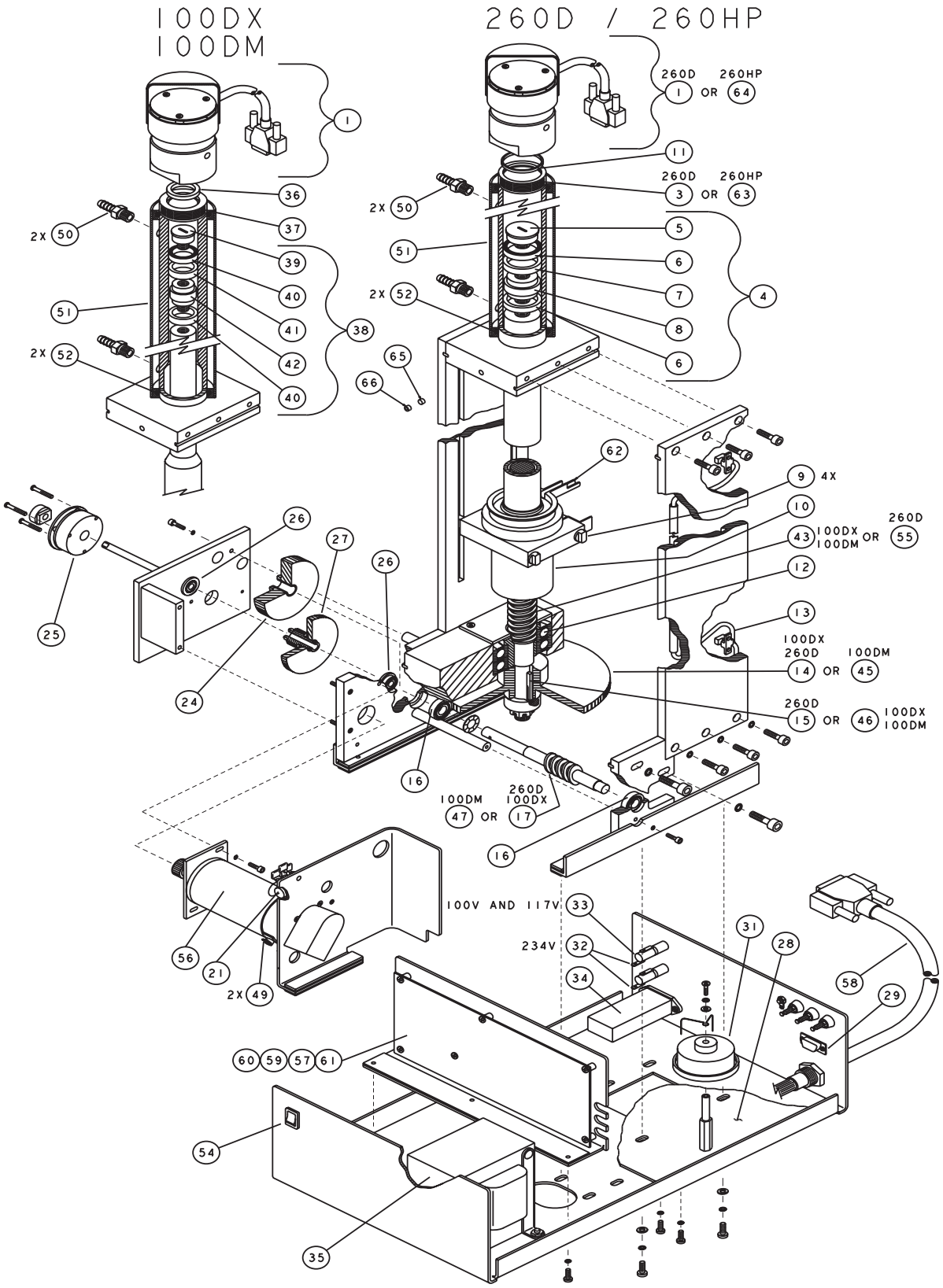
REV:

TELEDYNE ISCO

ITEM NO.	PART NUMER	DESCRIPTION
29	601244221	PSTN ASSY 500 ML (NITRONIC)
29	601244319	PSTN ASSY 500 ML (HASTELLOY)
30	601244323	HARN MN PMP - ENCD
31	601244458	TERM BLK,INDUCTOR,DUAL MOTOR
32	601244459	TERM STRIP ASSY L3-L4, 2-MOTOR
33	601244460	TERM STRIP ASSY L1-L2, 2-MOTOR
34	601244461	WIRING ASSY, XFRMR, DUAL MOTOR
35	601247172	REPLACEMENT KIT,POWER CBA,500HPX
36	601244463	ASSY,TWO MOTOR,DUAL MOTOR PUMP
37	601244465	HARN MOT / BRAKE
38	601244466	ASSY,FAN/COVER,BOTTOM
39	601248099	JKT CLG ASSY 500ML KB
40	601248116	B NUT ASSY KB
41	601248117	B SCR ASSY
42	601244469	PREAMP ASSY, CYL CAP (NITRONIC)
42	601244468	PREAMP ASSY, CYL CAP (HASTELLOY)
43	602254132	MOTOR BRUSHES, PKG (2)
44	691243171	FRONT LABEL
45	691243431	WORM GEAR
46	691243455	CYL CAP SEAL 500D
47	691243560	SPUR GEAR, 50T, 20P
48	691243563	EXTENDED WORM GEAR
49	691243805	COMBINATION GEAR
50	691243806	GR PIN HLCL/DX

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

A.1.6 100DM/DX and 260D Pumps



REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-321
SHEET: 2 OF 3
REV.: N DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60-1244-235	PREAMPLIFIER CBA ASSY
3	69-1243-576	260ML NITRONIC CYLINDER
4	60-1244-216	PISTON ASSY
5	60-1243-414	SEAL RETAINER
6	202-9091-06	SEAL
7	60-1243-537	WEAR RING
8	60-1243-534	PISTON BASE
9	60-1243-348	THRUST BEARING
10	60-1248-116	BALL NUT ASSY
11	69-1243-444	CYLINDER SEAL
12	201-4299-02	THRUST BEARING (INDIVIDUAL, ORDER 2 EA)
13	69-1244-415	UNIVERSAL SENSOR HARNESS
14	69-1243-431	WORMGEAR (260D, 100DX)
15	60-1243-607	KEY
16	201-0329-00	BEARING (SEE NOTE 3)
17	69-1243-563	EXTENDED WORM GEAR (260D, 100DX)
21	113-3250-00	CAP 5uF 100VDC
24	69-1243-560	GEAR SPUR
25	150-0006-01	BRAKE
26	201-1337-00	BEARING (SEE NOTE 3)
27	69-1243-800	COMBINATION GEAR
28	60-1243-492	SOAK PAD
29	141-4001-02	D-SUB SOCKET
31	60-1244-236	LUBE WHEEL ASSY
32	411-0311-51	FUSE 1 AMP "T"
33	411-0311-62	FUSE 2 AMP "T"
34	120-0013-00	POWER FILTER 6A
35	60-1244-309	TRANSFORMER ASSY
36	69-1243-465	CYLINDER CAP SEAL
37	69-1243-575	100ML CYLINDER
38	60-1244-223	PISTON ASSY
39	60-1243-468	PISTON SEAL RETAINER
40	202-9090-75	SEAL

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

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REPLACEMENT PARTS LIST
Teledyne Isco, Inc.

DWG. NO.: 60-1242-321
SHEET: 3 OF 3
REV.: N DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
41	60-1243-536	WEAR RING
42	60-1243-533	PISTON BASE
43	60-1248-127	BALL SCREW ASSY (100DM, 100DX)
45	69-1243-485	WORM GEAR (100DM)
46	60-1243-608	KEY (100DM, 100DX)
47	69-1243-605	EXTENDED WORM GEAR (100DM)
48	60-1244-220	GEAR LUBRICATION ASSY (NOT SHOWN)
49	60-2254-132	MOTOR BRUSHES
50	209-0161-00	MALE HOSE CONNECTOR
51	60-1248-053	COOLING JACKET ASSY
52	202-2062-23	O-RING, 1.609 ID, .139 CROSS SECTION
54	410-7304-01	SW DPDT ROCKER CSA 4A
55	60-1248-117	BALL SCREW ASSY (260D)
56	60-1244-444	MOTOR MOUNT ASSEMBLY
57	60-1245-158	CBA FOR SYRINGE PUMP DRIVE UNITS, 100DM
58	60-1244-323	MAIN HARNESS
59	60-1245-159	CBA FOR SYRINGE PUMP DRIVE UNITS, 100DX
60	60-1245-160	CBA FOR SYRINGE PUMP DRIVE UNITS, 260D
61	60-1245-174	CBA MOTOR DRIVE
62	60-1243-201	DRIP PAN
63	69-1243-848	260ML HIGH STRENGTH NITRONIC CYLINDER
64	60-1244-456	260HP PREAMPLIFIER ASSEMBLY
65	60-1243-291	DELRIN PLUG
66	231-2007-04	SET SCREW 1/4-20 X 1/4

Note: 1. For current prices and quotations on parts, contact Isco Customer Service Department.
2. This list is subject to change without notice.
3. Verify the part number with Isco Technical Service Department.

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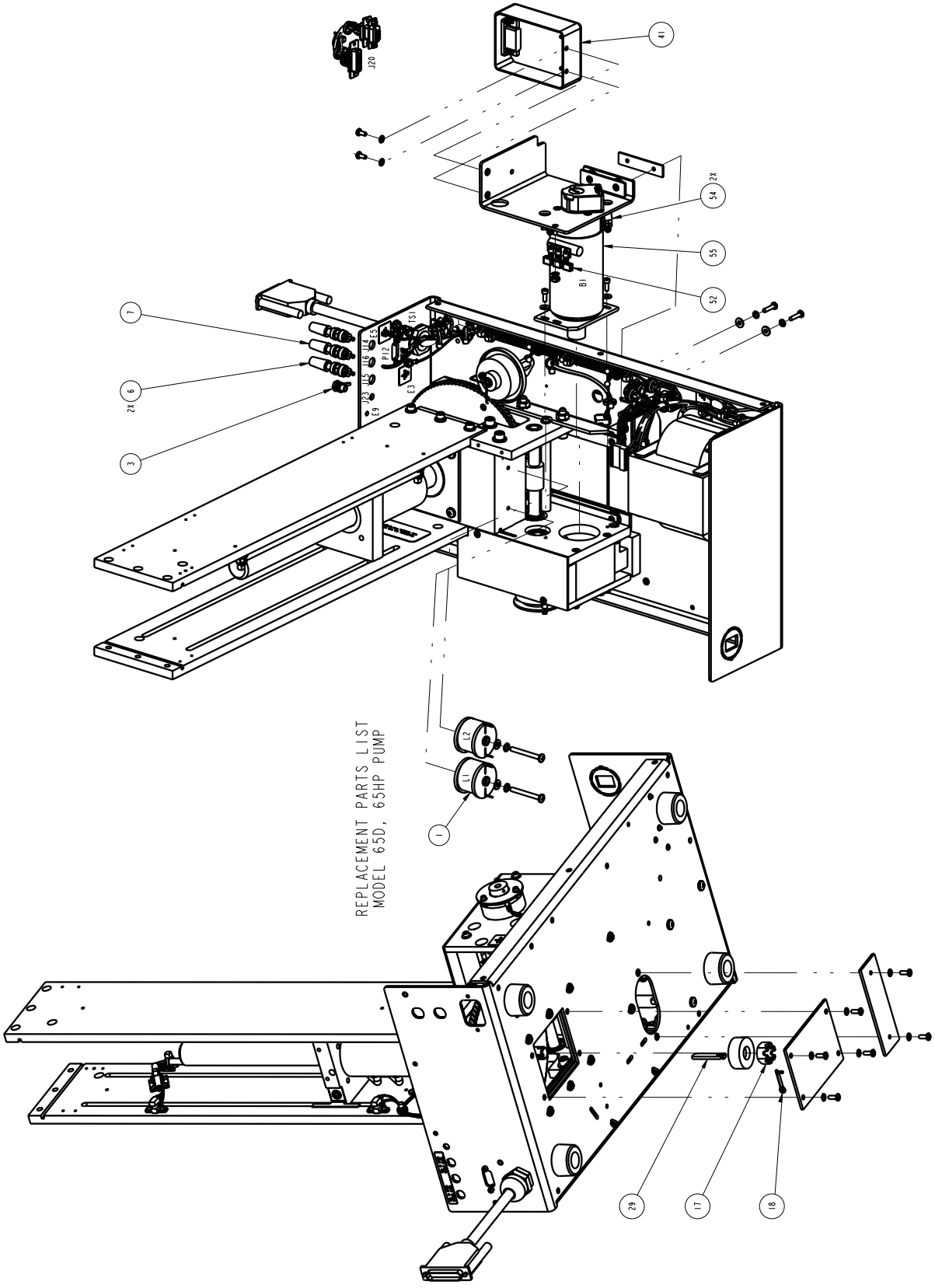
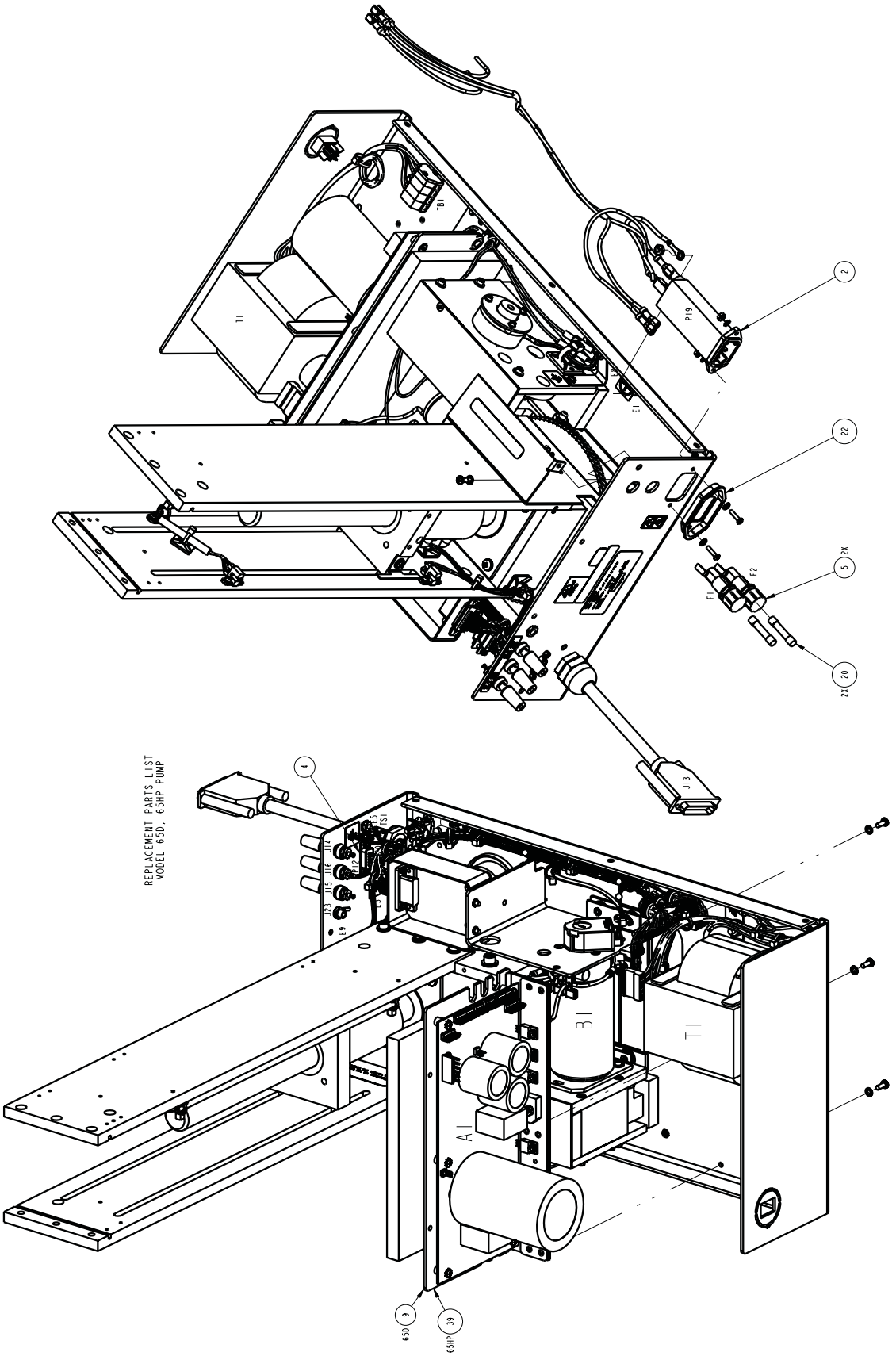
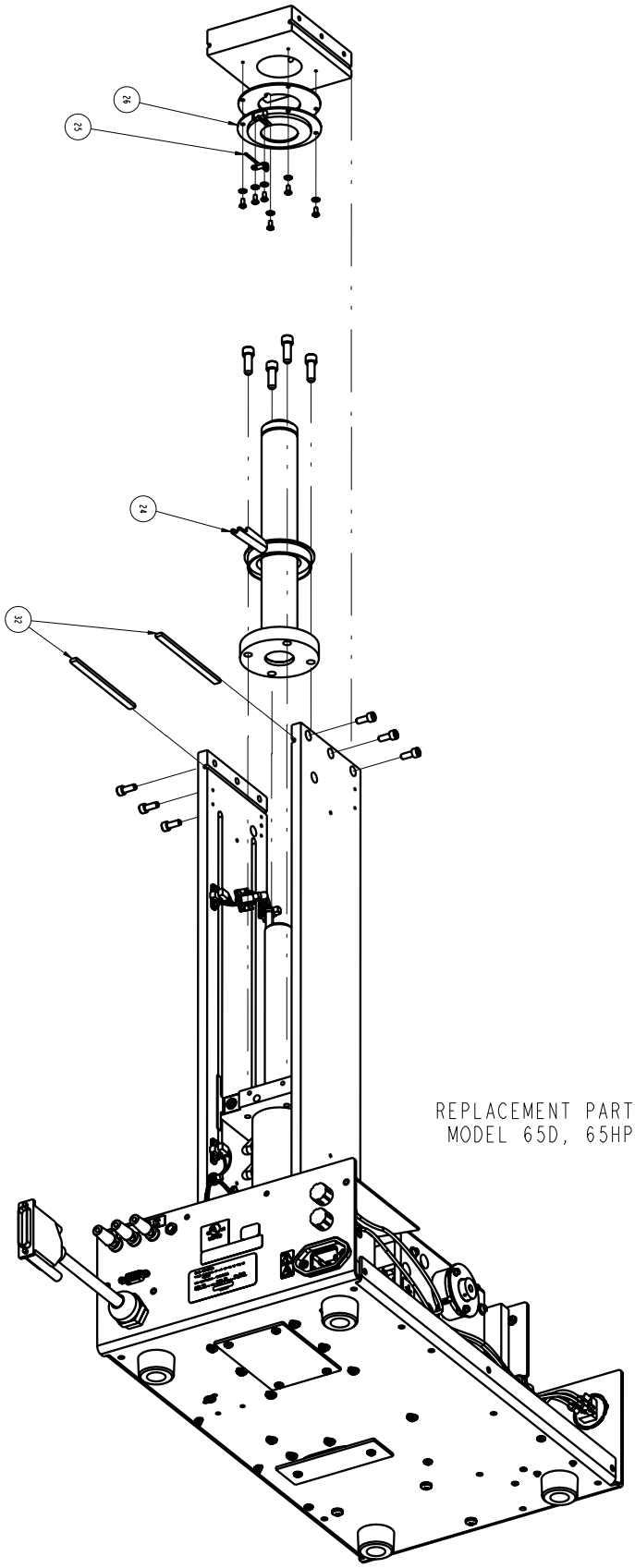
A.1.7 65D Pump




REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
TB1
T1
P19
E1
J13
F1
F2
J14
J16
J15
J23
E9
E5
TS1
C3
A1
B1
T1
2
22
5
2X
20
2X
4
9
65D
39
65HP



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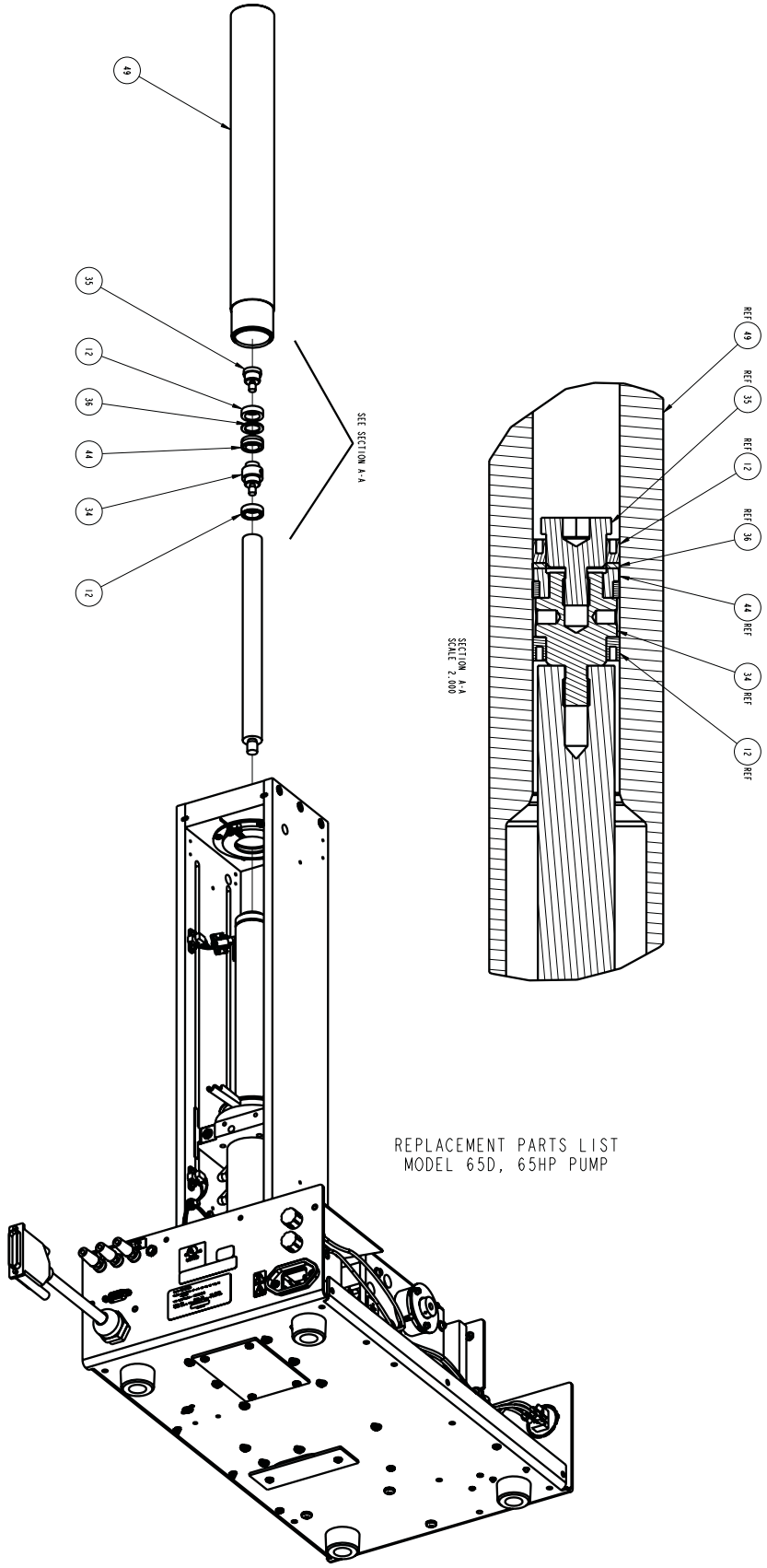
MODEL 65D, 65HP PUMP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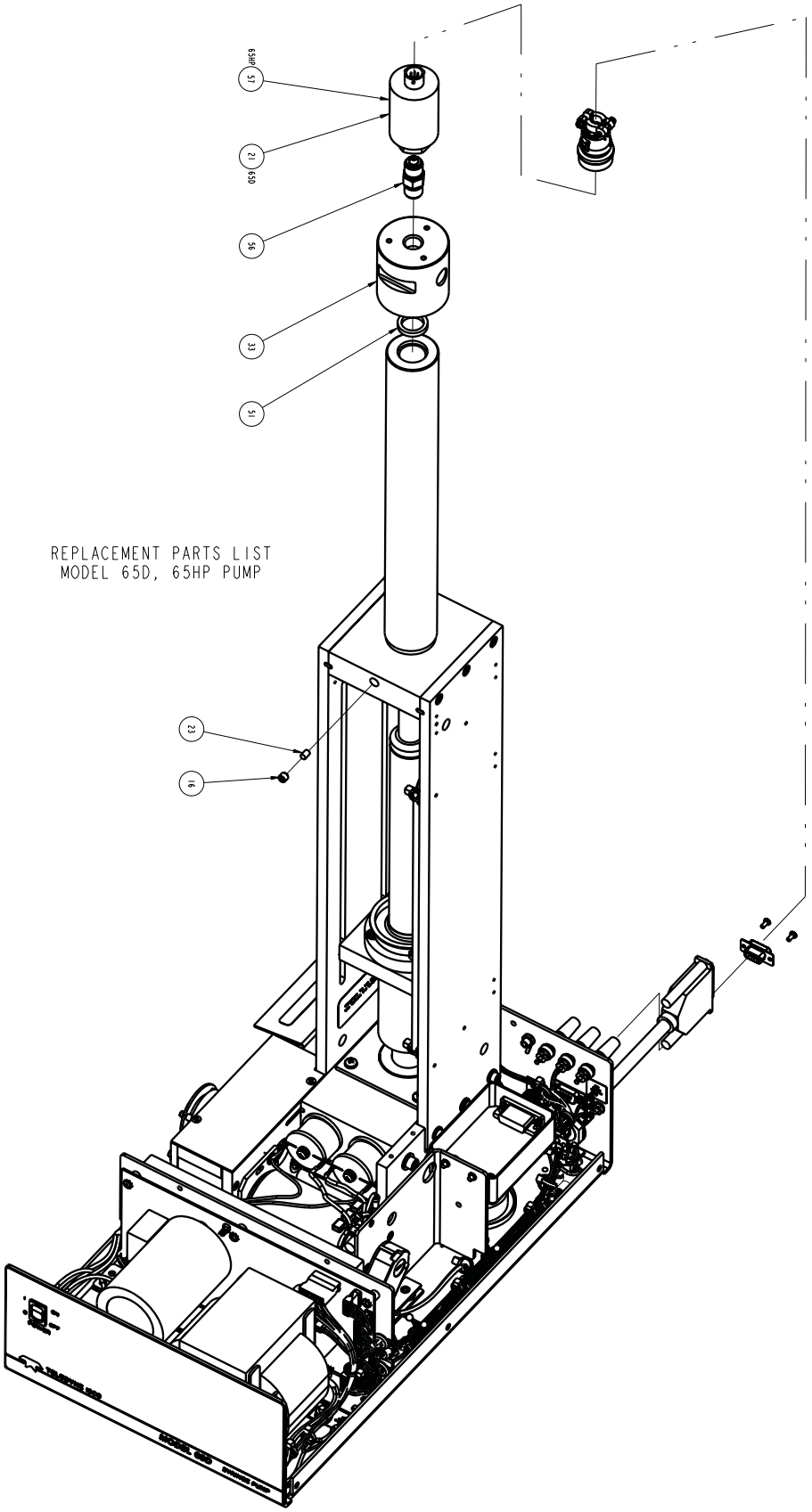
REF 49
REF 55
REF 12
REF 36
44 REF
34 REF
12 REF
SECTION A-A
SCALE 2.000
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP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J2
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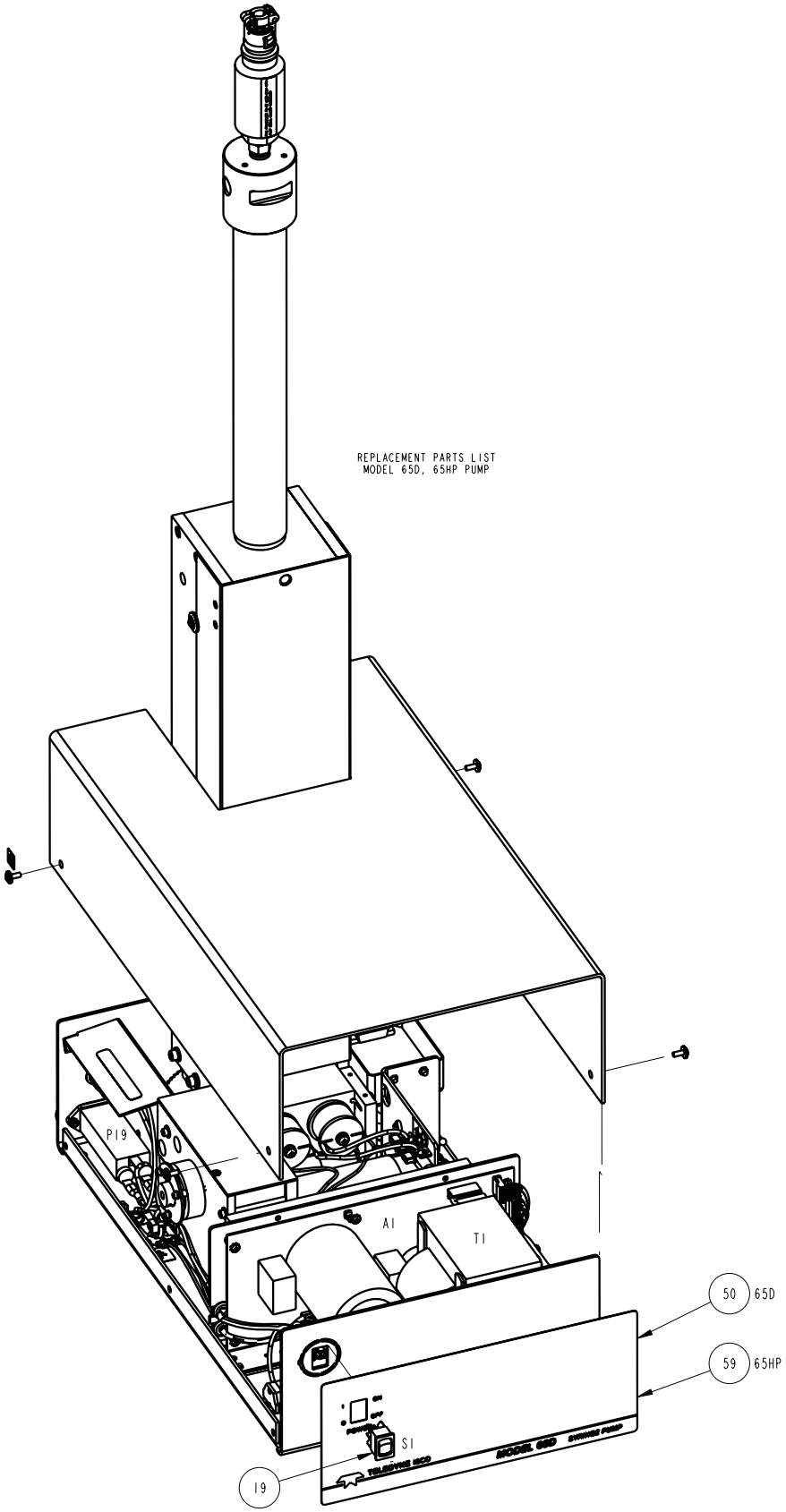
S6
E3
S1
J2
J1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65D
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65HP
S1
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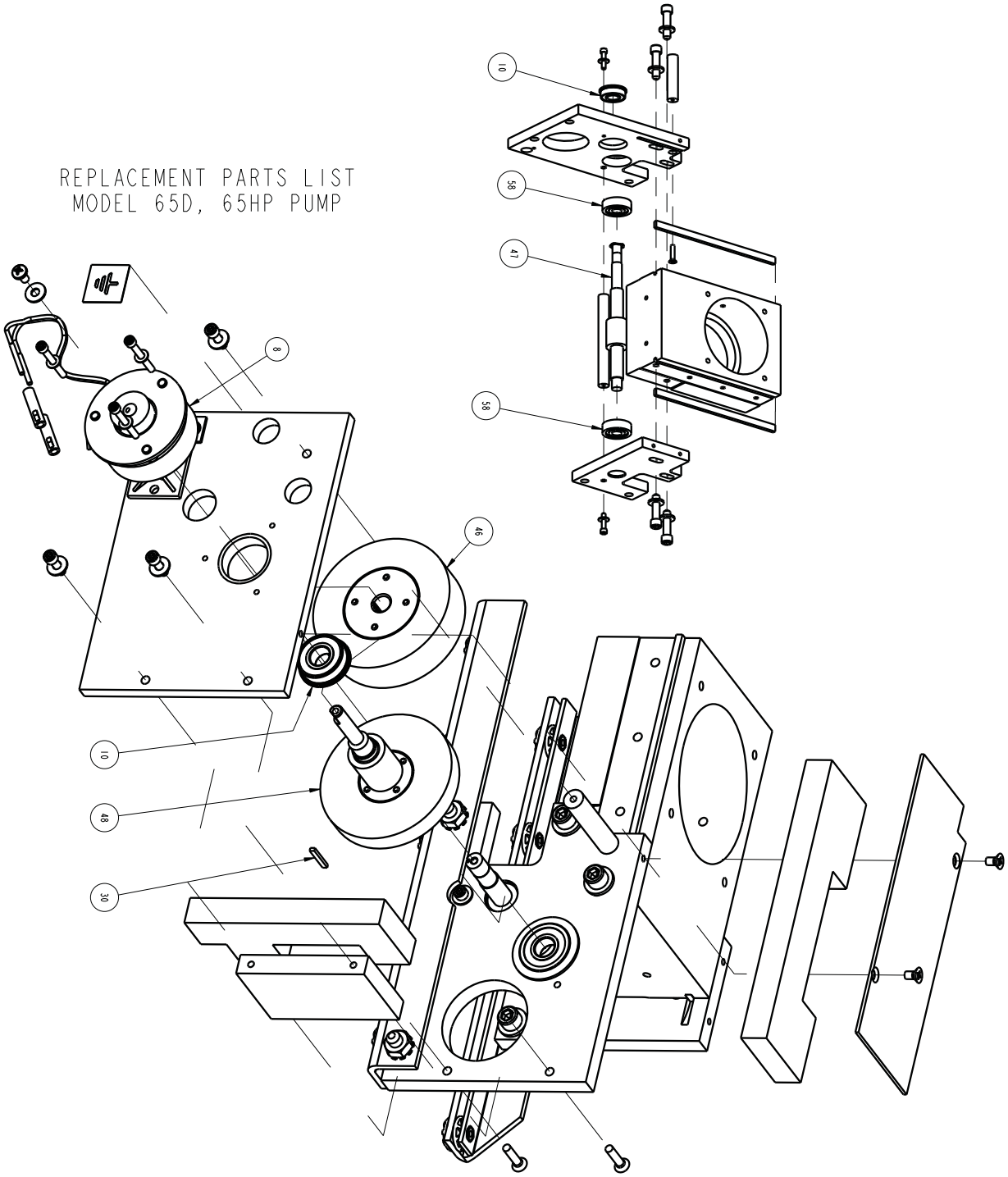
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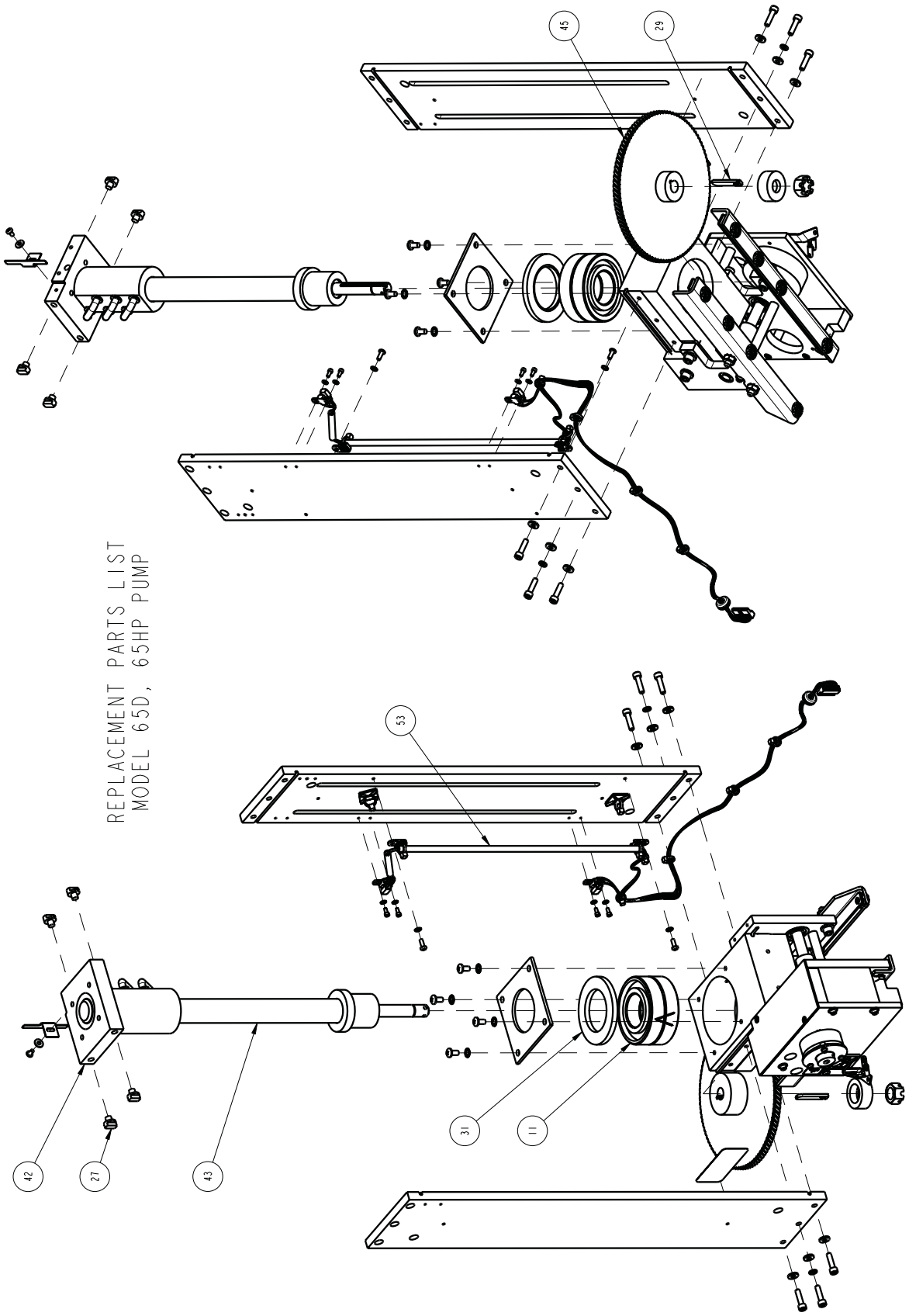
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MODEL 65D, 65HP PUMP
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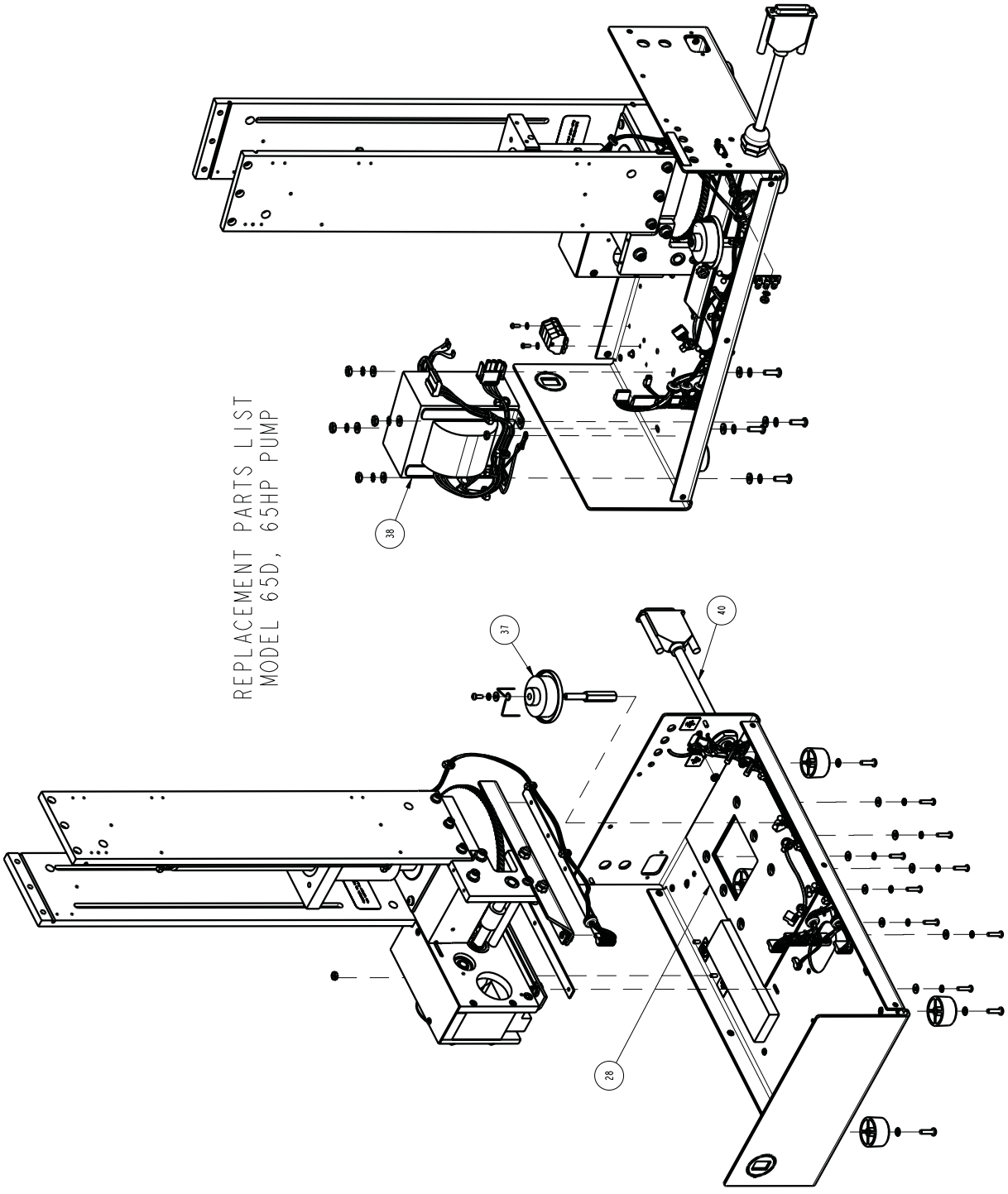
REPLACEMENT PARTS LIST
MODEL 65D, 65HP PUMP
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37
40
28

601242498

SHEET: 11 OF 13

REPLACEMENT PARTS LIST

TELEDYNE ISCO

ITEM NO.	PART NUMBER	DESCRIPTION
1	201-1337-00	BEARING (VERIFY PART# WITH ISCO SERVICE DEPT)
2	201-0329-00	BEARING CYLINDER
3	69-1243-563	EXTENDED WORM GEAR
4	150-0006-01	BRAKE, FAILSAFE REVERSE, 24V, .25 BORE
5	60-1243-610	GEAR TRAIN KEY
6	69-1243-560	SPUR GEAR
7	69-1243-800	COMBINATION GEAR
8	201-4299-02	THRUST BALL BEARING,INDIVIDUAL (ORDER 2 EA)
9	60-1243-624	BEARING RETAINING RING
10	60-1248-127	BALL SCREW ASSY
11	60-1243-348	SLIDE THRUST BEARING
12	60-1248-116	BALL NUT ASSY
13	69-1244-415	HARNESS, UNIVERSAL SENSOR
14	232-6097-00	SLOTTED HEX NUT, 1/2-20, STEEL
15	201-6299-52	THRUST WASHER, 1-1/4
16	201-6299-02	THRUST BEARING, 1-1/4
17	201-6299-51	THRUST WASHER, 1-3/8
18	201-6299-01	THRUST BEARING, 1-3/8
19	60-1245-168	WORM GEAR MOD
20	60-1243-949	SHEAR KEY
21	236-0008-12	COTTER PIN, .125 X .75 LONG, SST OR STL
22	60-1244-309	TRANSFORMER ASSY
23	60-1244-23	

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 12 OF 13

REV: A

TELEDYNE ISCO

ITEM NO.	PART NUMBER	DESCRIPTION
26	60-1244-323	MAIN HARNESS
27	120-0007-01	CHOKE, 330UH, 11 AMP
28	141-3500-20	PANEL MOUNT BANANA JACK
29	143-4007-00	BINDING POST, RED
30	143-4008-00	BINDING POST, BLACK
31	69-1244-411	TERMINAL STRIP ASSY
32	60-1244-184	MOTOR ASSY
33	60-2254-132	MOTOR BRUSHES (PKG OF 2)
34	60-1245-169	MOTOR DRIVE CBA MOD, 65DM
35	411-0311-62	FUSE, 2 AMP (FOR 100/117V UNITS)
36	60-0823-201	DRIP SHIELD
37	142-1104-00	FUSE HOLDER
38	120-0013-00	POWER FILTER, 6 AMP
39	60-1243-234	NITROGEN PURGE PAN
40	60-1243-202	NITROGEN PURGE TUBE
41	60-1243-201	DRIP PAN
42	60-1243-682	KEY
43	69-1243-947	CYLINDER, 65DM SYRINGE PUMP
44	60-1243-883	SEAL RETAINER, 65ML
45	202-9096-08	SEAL, .563 ID X .813 OD
46	60-1243-901	BACK UP RING, 65D PRIMARY SEAL
47	60-1248-182	WEAR RING, 65ML
48	60-1243-882	PISTON BASE, 65ML
49	410-7304-01	ROCKER SWITCH, DPDT, 4 AMP
50	69-1243-948	FRONT PANEL LABEL, 65DM

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 13 OF 13

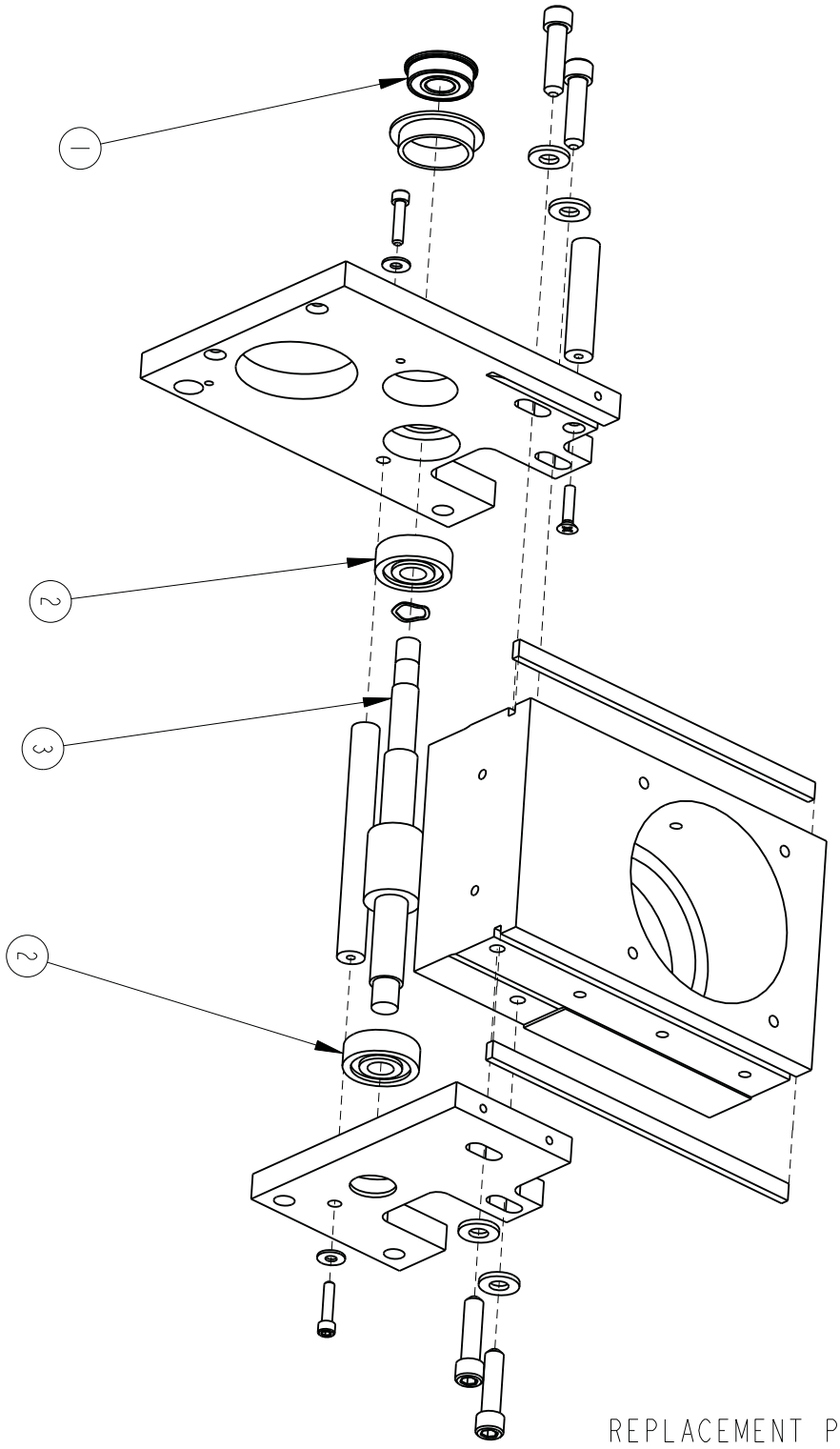
REV: A

TELEDYNE ISCO

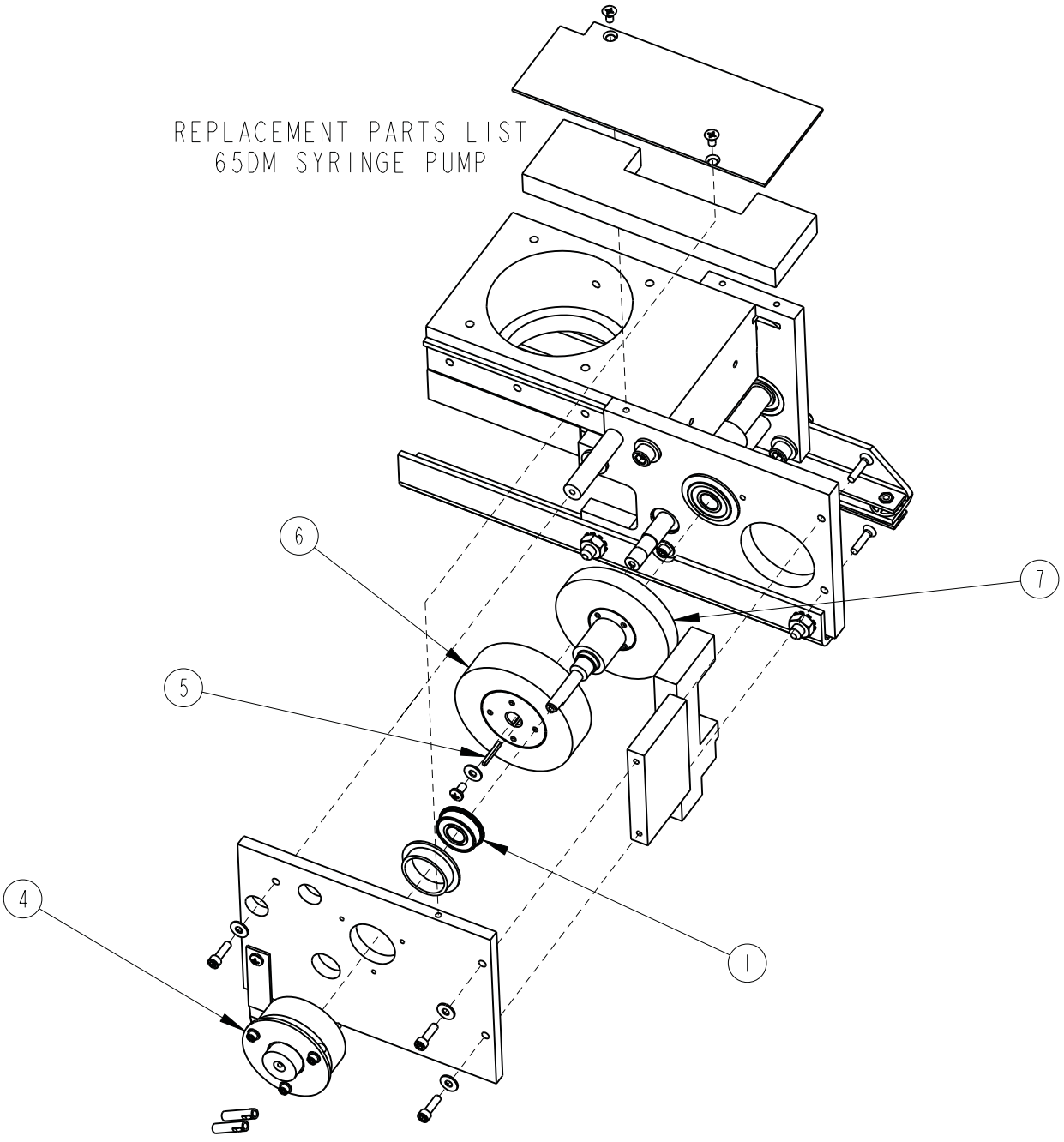
ITEM NO.	PART NUMBER	DESCRIPTION
51	60-1244-235	CALIBRATED PREAMP ASSY
52	69-1243-465	CYLINDER CAP SEAL
53	60-1243-291	DELRIN PLUG
54	231-2007-04	SET SCREW, 1/4-20 X 1/4, CUP POINT

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

A.1.8 65DM



REPLACEMENT PARTS LIST
65DM SYRINGE PUMP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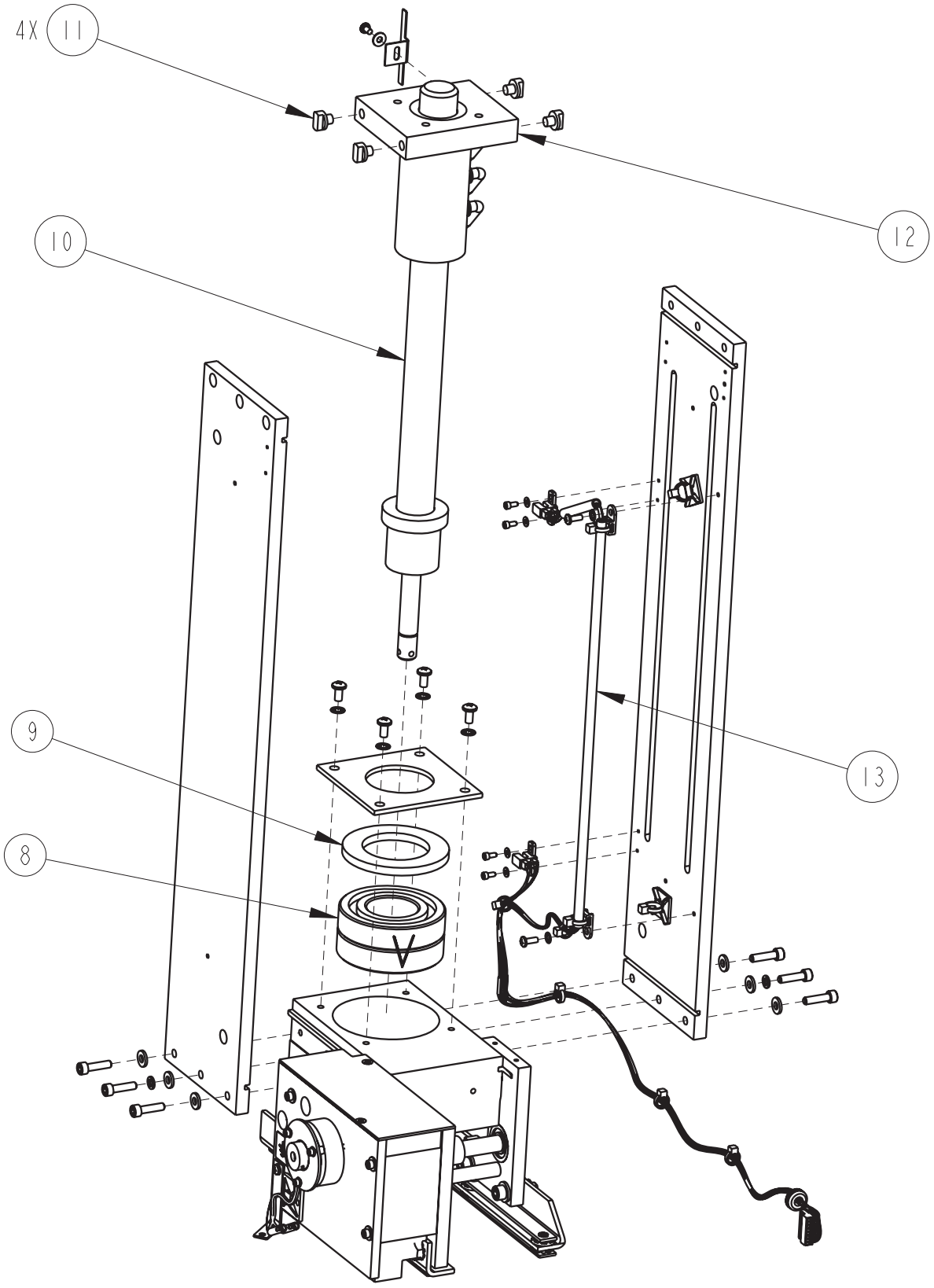
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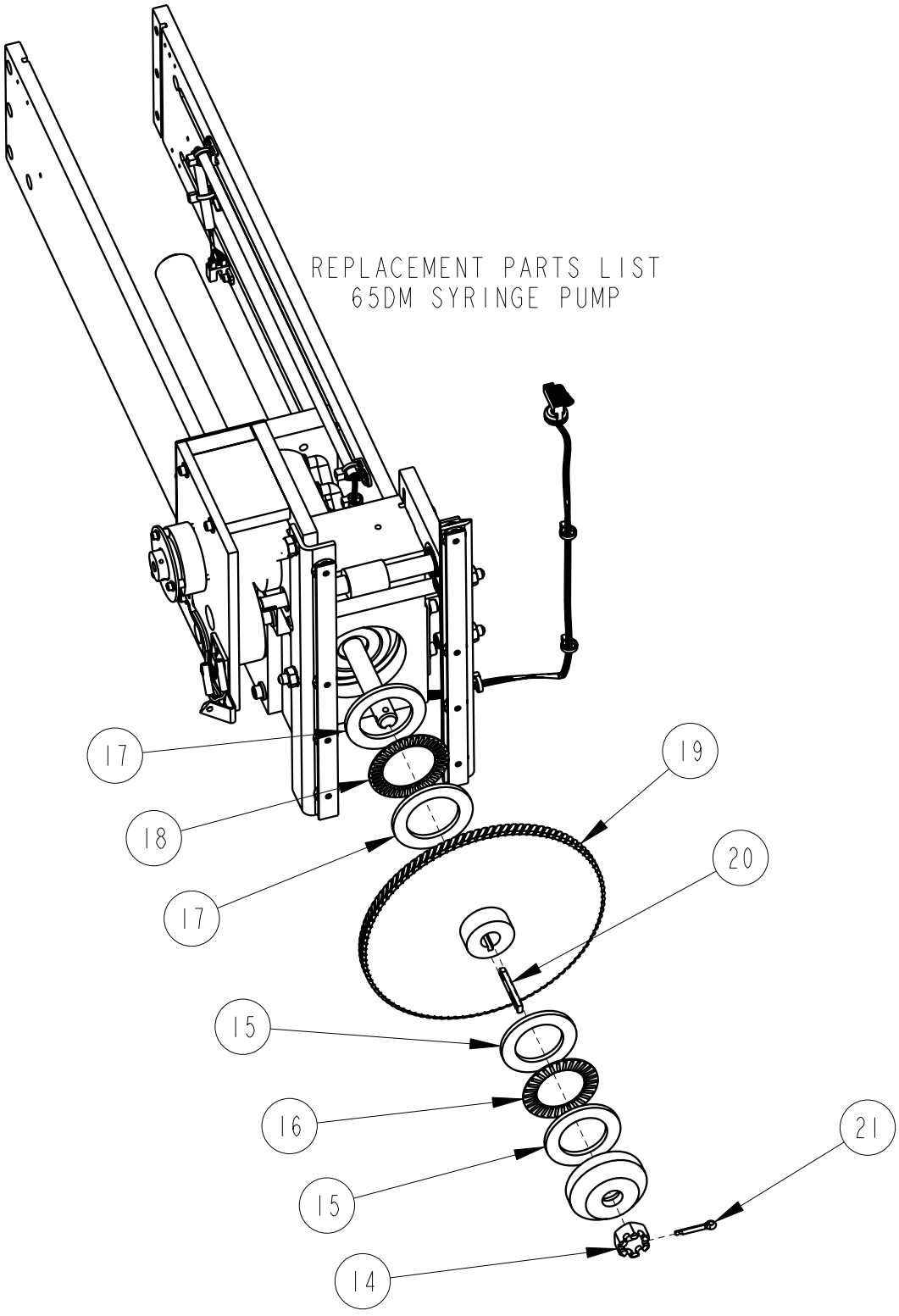
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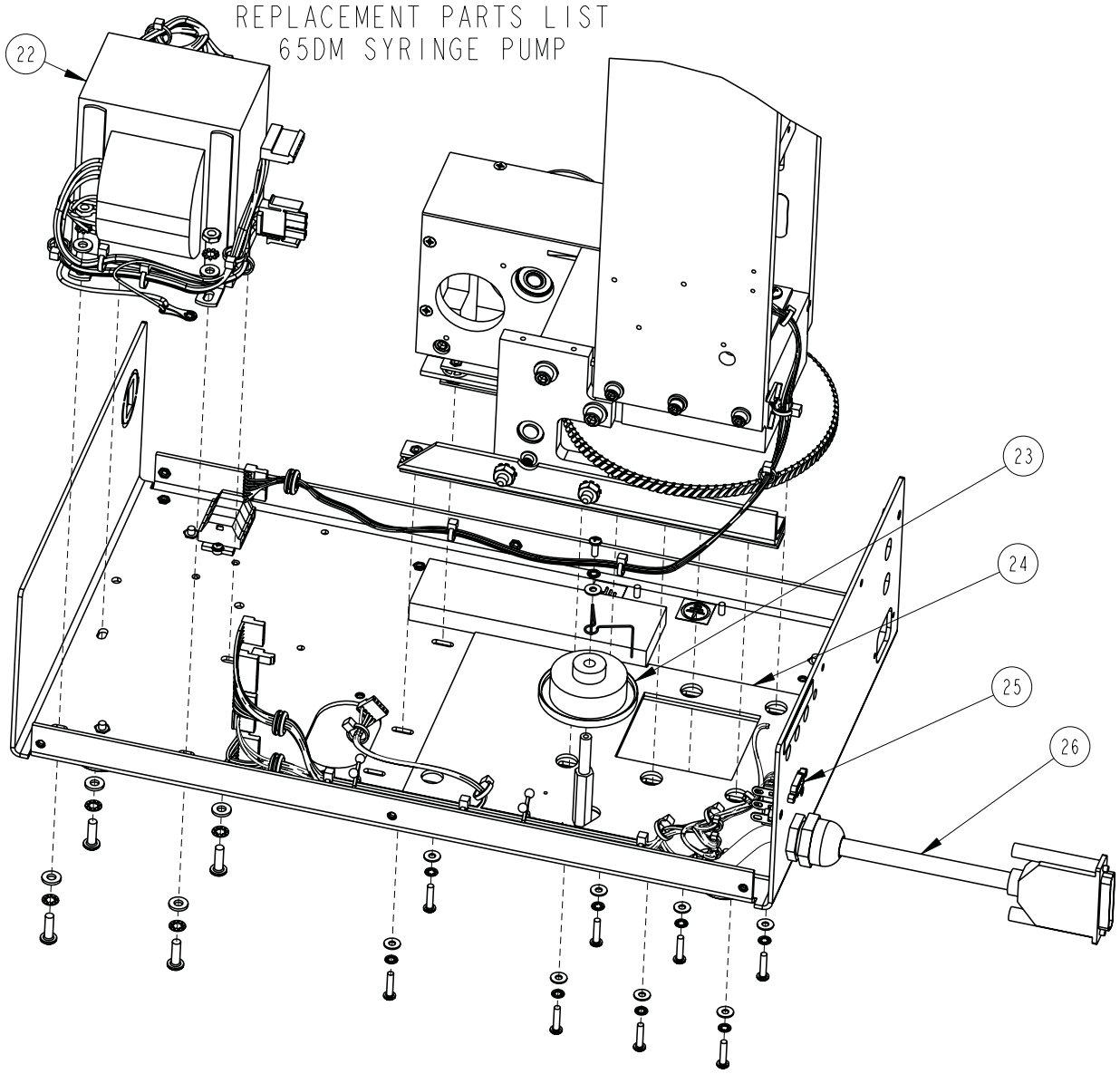
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65DM SYRINGE PUMP
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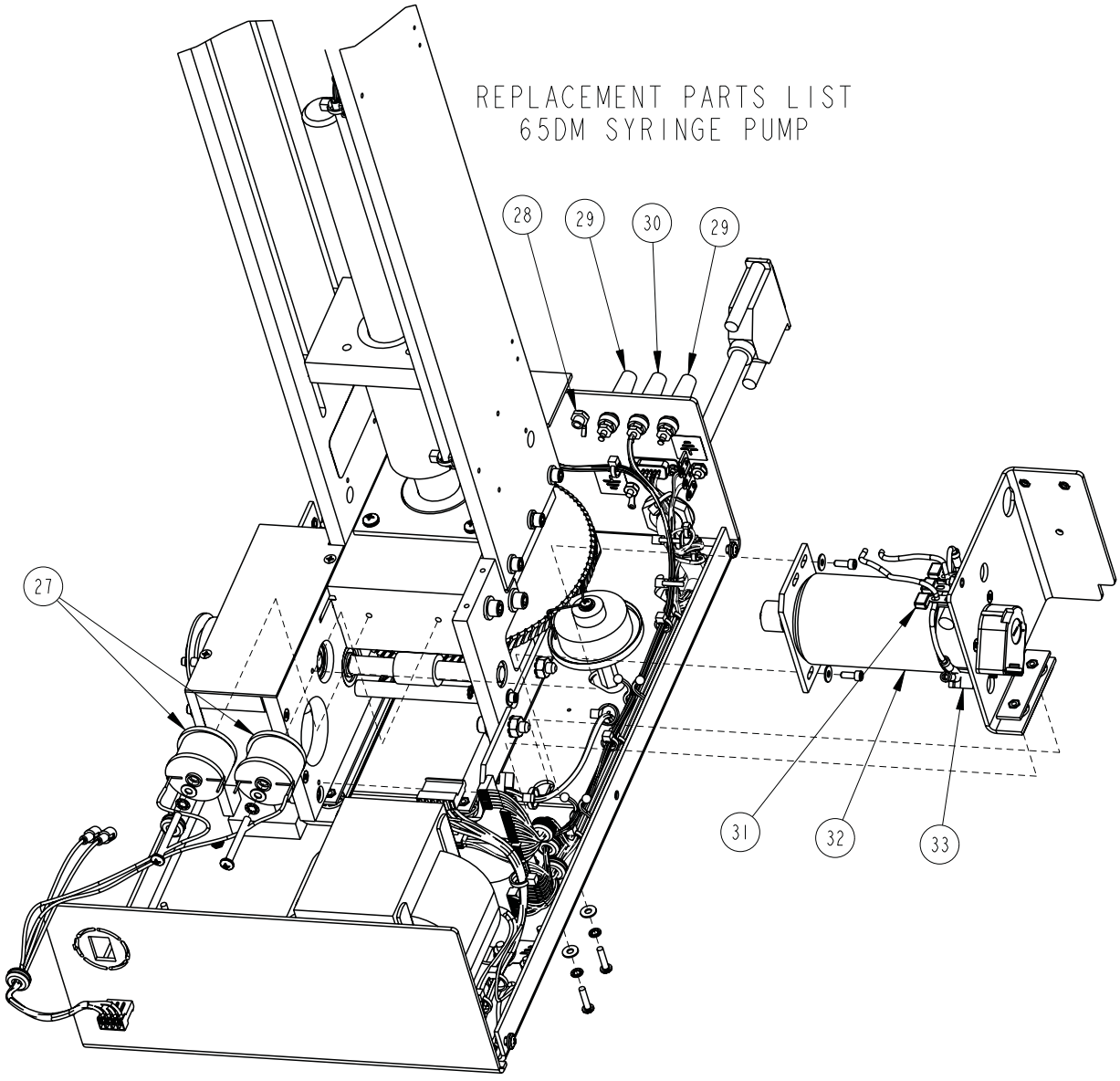
REPLACEMENT PARTS LIST
65DM SYRINGE PUMP
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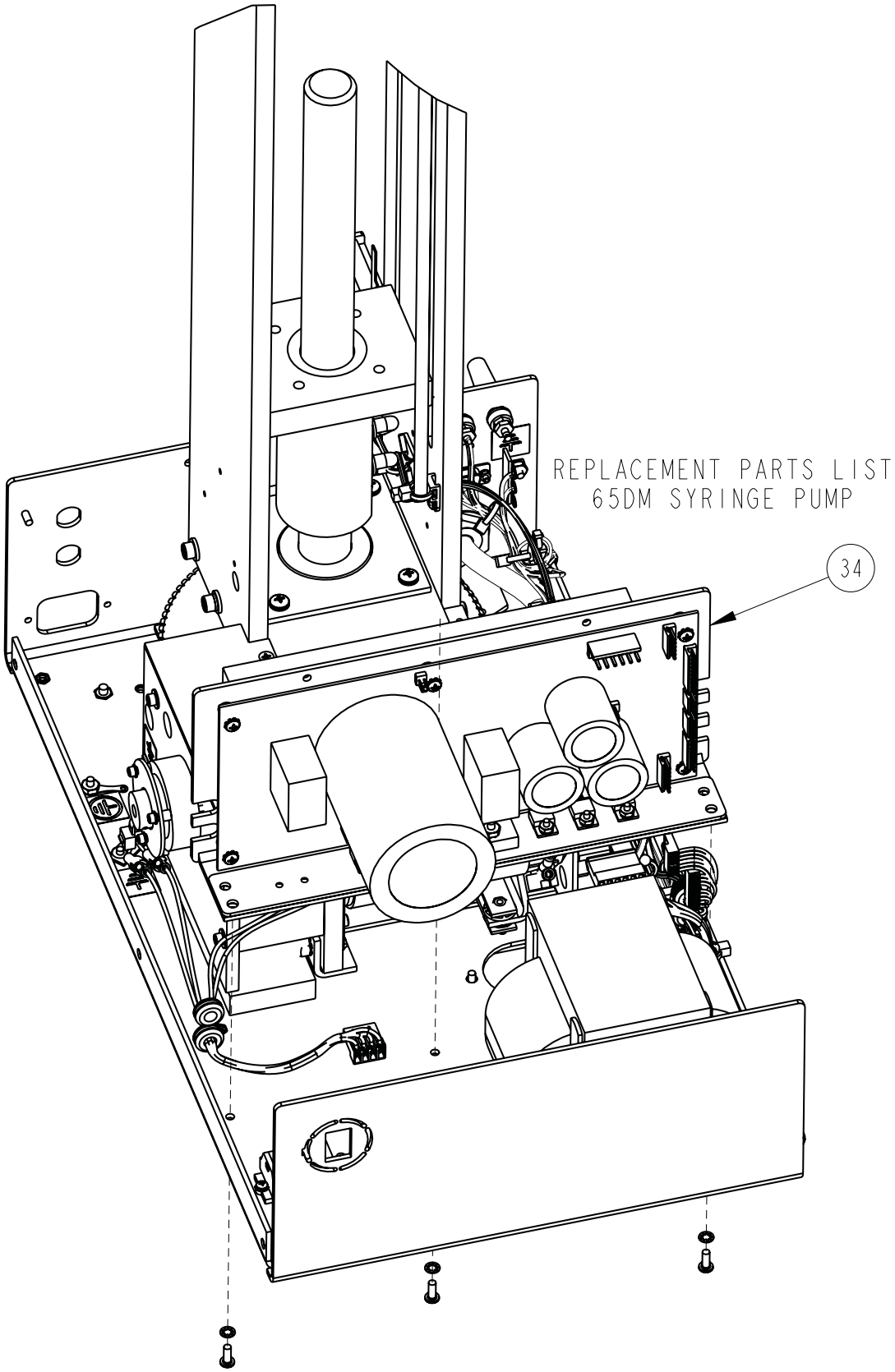
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65DM SYRINGE PUMP
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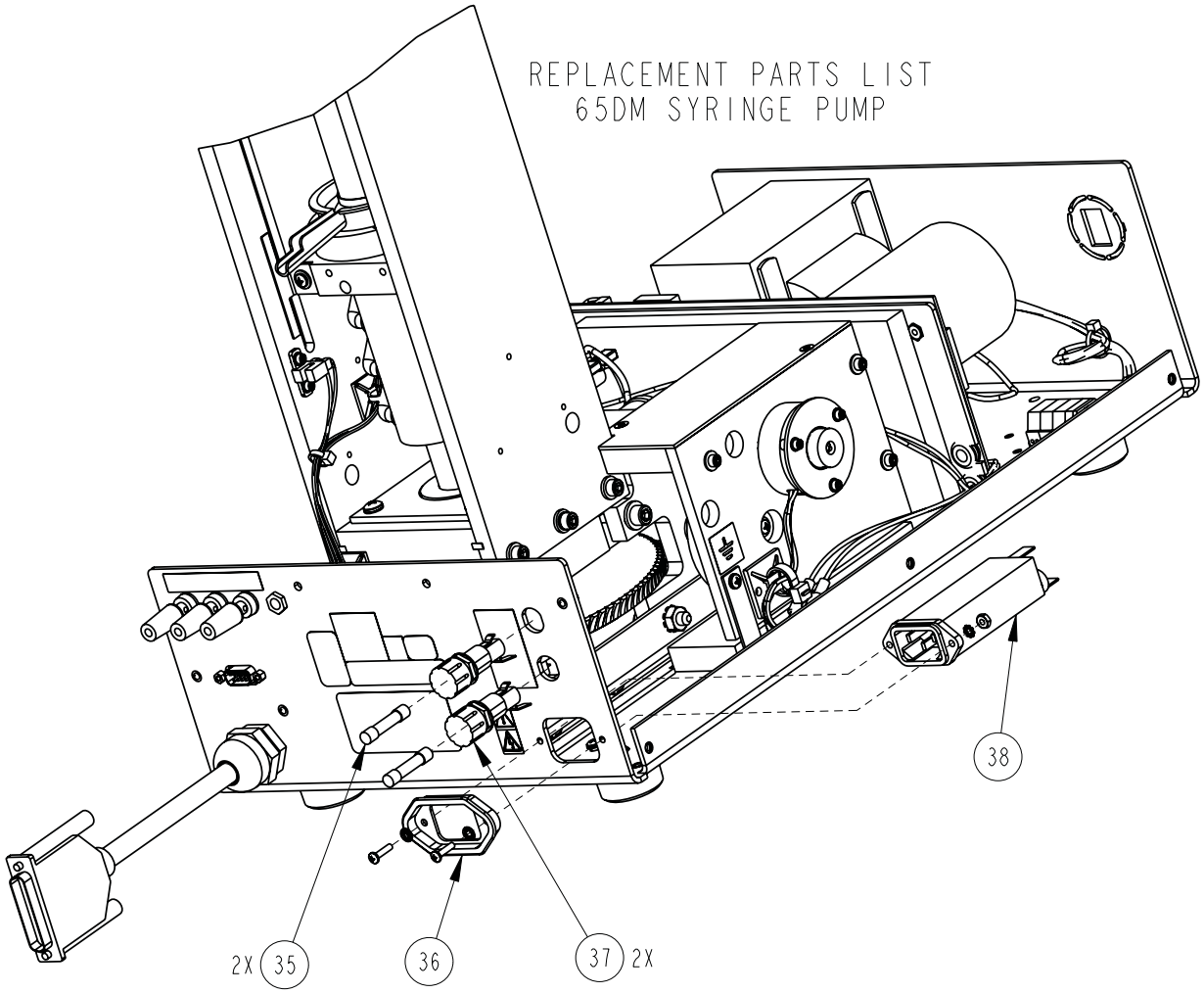
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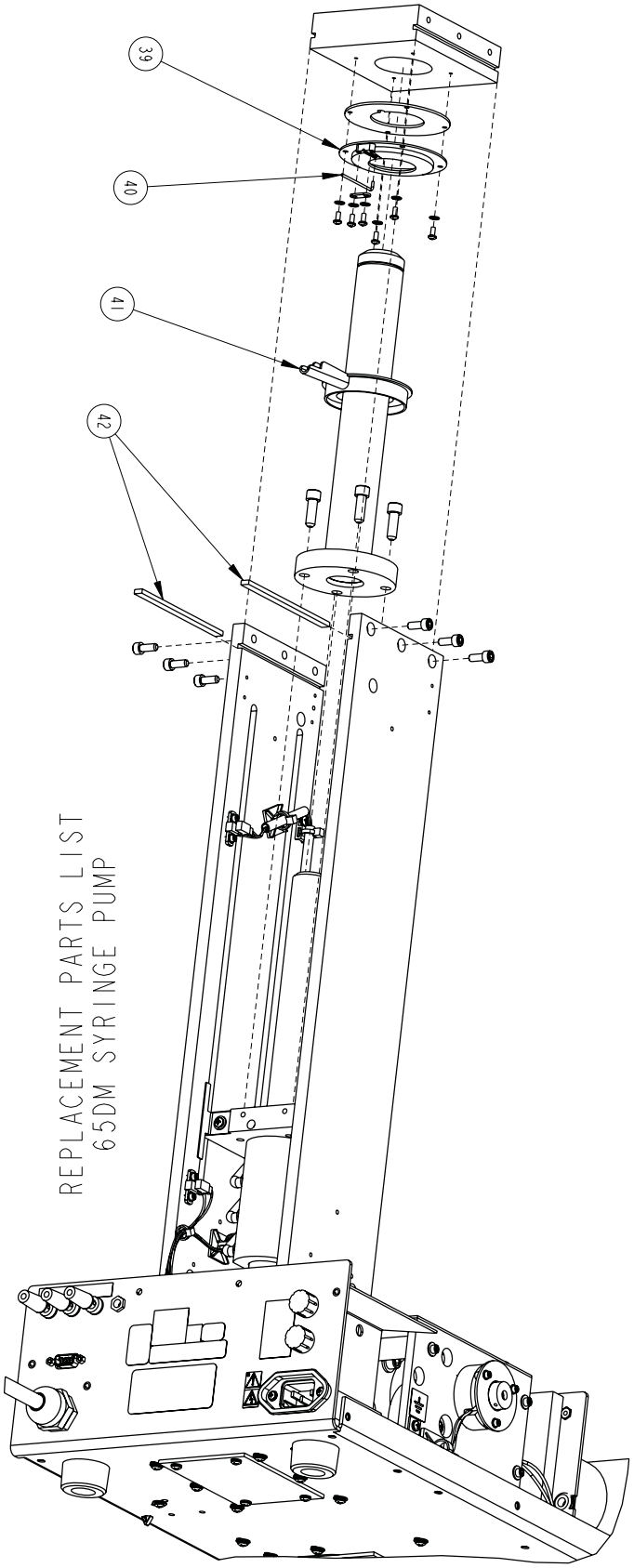
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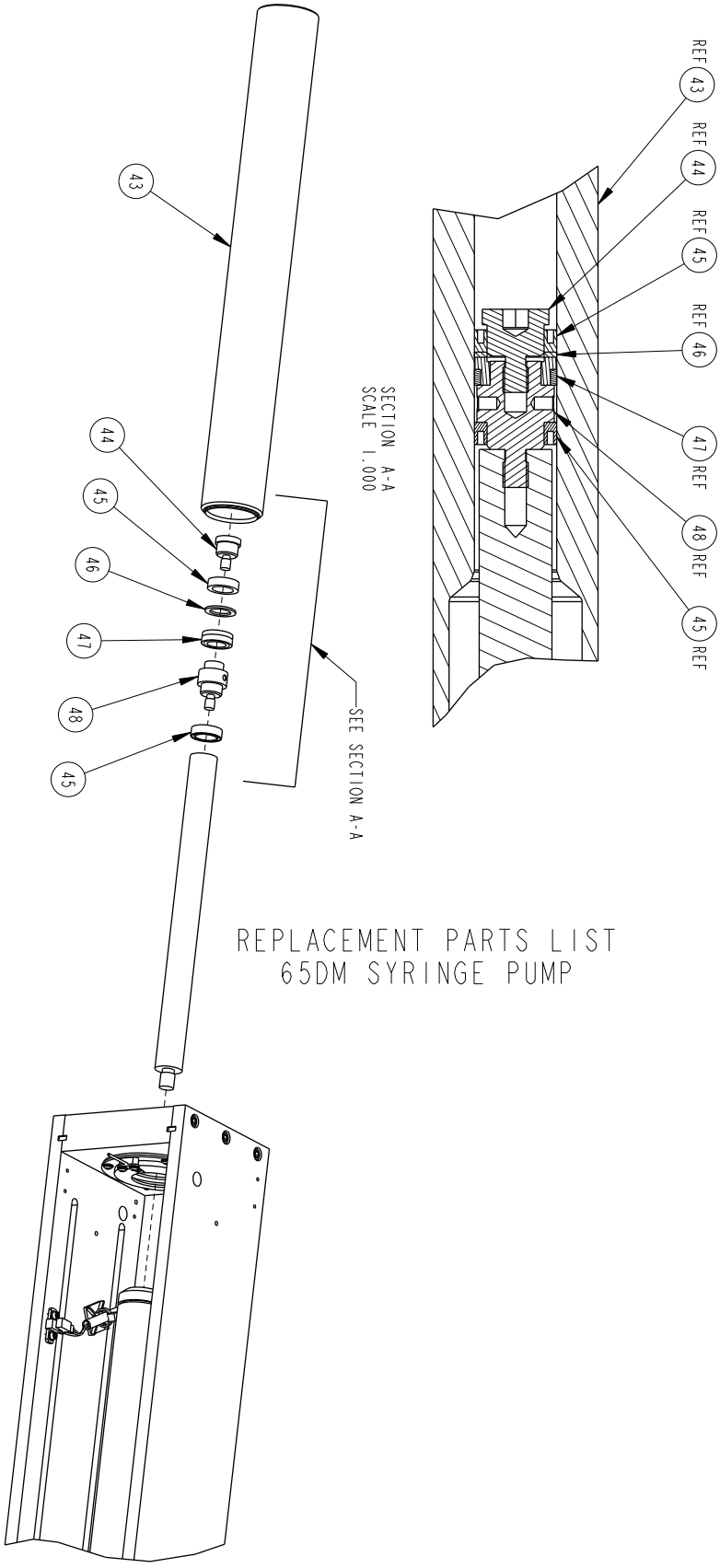
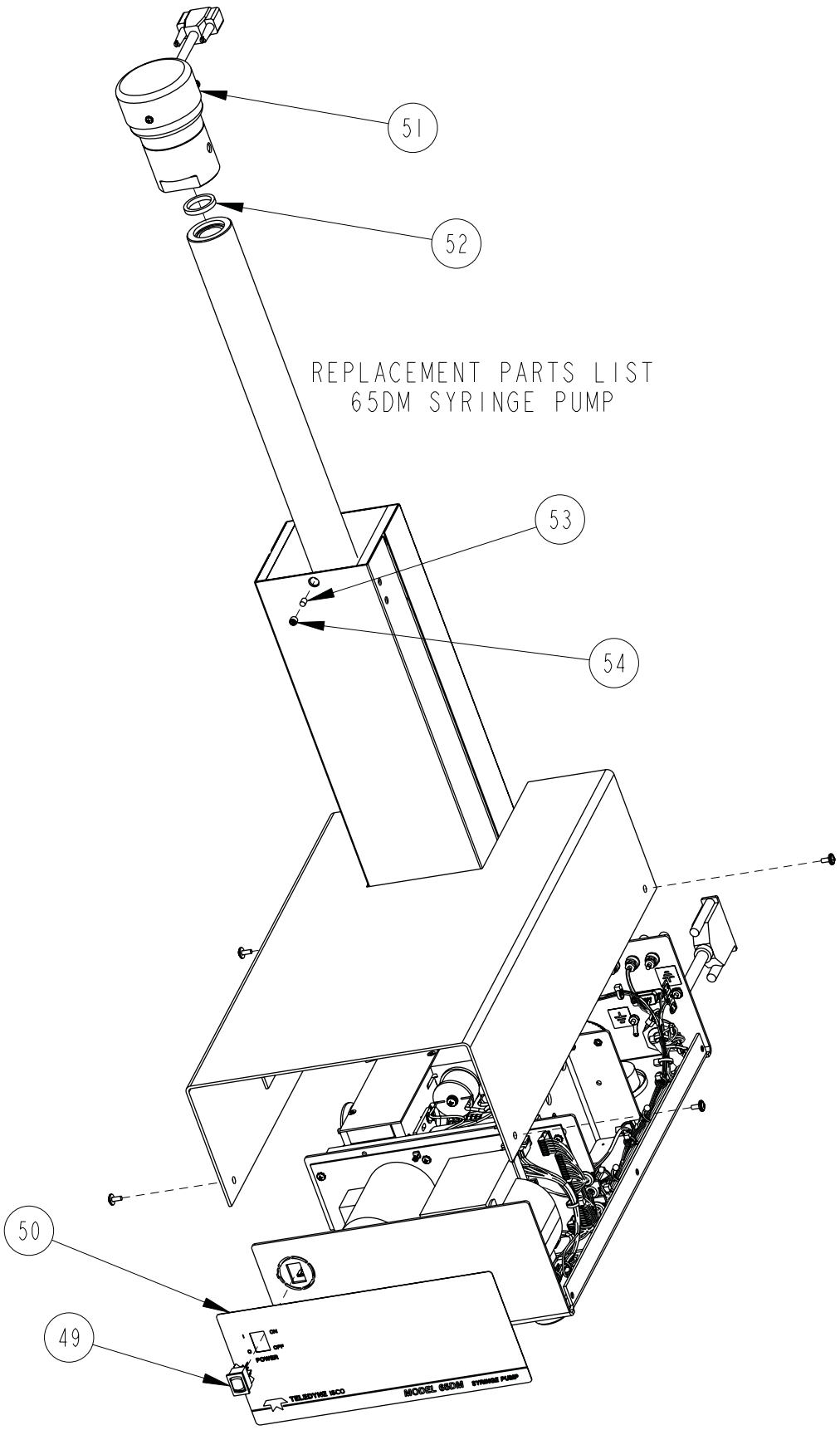
REPLACEMENT PARTS LIST
65DM SYRINGE PUMP



REPLACEMENT PARTS LIST
65DM SYRINGE PUMP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REPLACEMENT PARTS LIST
65DM SYRINGE PUMP
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54
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ON
OFF
POWER
TELEDYNE ISCO
MODEL 65DM SYRINGE PUMP

601242498

REPLACEMENT PARTS LIST

SHEET: 11 OF 13

TELEDYNE ISCO, INC.

REV:

ITEM NO.	PART NUMBER	DESCRIPTION
1	201-1337-00	BEARING (VERIFY PART# WITH ISCO SERVICE DEPT)
2	201-0329-00	BEARING CYLINDER
3	69-1243-563	EXTENDED WORM GEAR
4	150-0006-01	BRAKE, FAILSAFE REVERSE, 24V, .25 BORE
5	60-1243-610	GEAR TRAIN KEY
6	69-1243-560	SPUR GEAR
7	69-1243-800	COMBINATION GEAR
8	201-4299-02	THRUST BALL BEARING, 35MM ID X 72MM OD
9	60-1243-624	BEARING RETAINING RING
10	60-1248-127	BALL SCREW ASSY
11	60-1243-348	SLIDE THRUST BEARING
12	60-1248-116	BALL NUT ASSY
13	69-1244-415	HARNESS, UNIVERSAL SENSOR
14	232-6097-00	SLOTTED HEX NUT, 1/2-20, STEEL
15	201-6299-52	THRUST WASHER, 1-1/4
16	201-6299-02	THRUST BEARING, 1-1/4
17	201-6299-51	THRUST WASHER, 1-3/8
18	201-6299-01	THRUST BEARING, 1-3/8
19	60-1245-168	WORM GEAR MOD
20	60-1243-949	SHEAR KEY
21	236-0008-12	COTTER PIN, .125 X .75 LONG, SST OR STL
22	60-1244-309	TRANSFORMER ASSY
23	60-1244-236	LUBE WHEEL ASSY
24	60-1243-492	SOAK PAD
25	141-4001-02	D-SUB SOCKET

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 12 OF 13

REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
26	60-1244-323	MAIN HARNESS
27	120-0007-01	CHOKE, 330UH, 11 AMP
28	141-3500-20	PANEL MOUNT BANANA JACK
29	143-4007-00	BINDING POST, RED
30	143-4008-00	BINDING POST, BLACK
31	69-1244-411	TERMINAL STRIP ASSY
32	60-1244-184	MOTOR ASSY
33	60-2254-132	MOTOR BRUSHES (PKG OF 2)
34	60-1245-169	MOTOR DRIVE CBA MOD, 65DM
35	411-0311-62	FUSE, 2 AMP (FOR 100/117V UNITS)
36	60-0823-201	DRIP SHIELD
37	142-1104-00	FUSE HOLDER
38	120-0013-00	POWER FILTER, 6 AMP
39	60-1243-234	NITROGEN PURGE PAN
40	60-1243-202	NITROGEN PURGE TUBE
41	60-1243-201	DRIP PAN
42	60-1243-682	KEY
43	69-1243-947	CYLINDER, 65DM SYRINGE PUMP
44	60-1243-883	SEAL RETAINER, 65ML
45	202-9096-08	SEAL, .563 ID X .813 OD
46	60-1243-901	BACK UP RING, 65D PRIMARY SEAL
47	60-1248-182	WEAR RING, 65ML
48	60-1243-882	PISTON BASE, 65ML
49	410-7304-01	ROCKER SWITCH, DPDT, 4 AMP
50	69-1243-948	FRONT PANEL LABEL, 65DM

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

601242498

REPLACEMENT PARTS LIST

SHEET: 13 OF 13

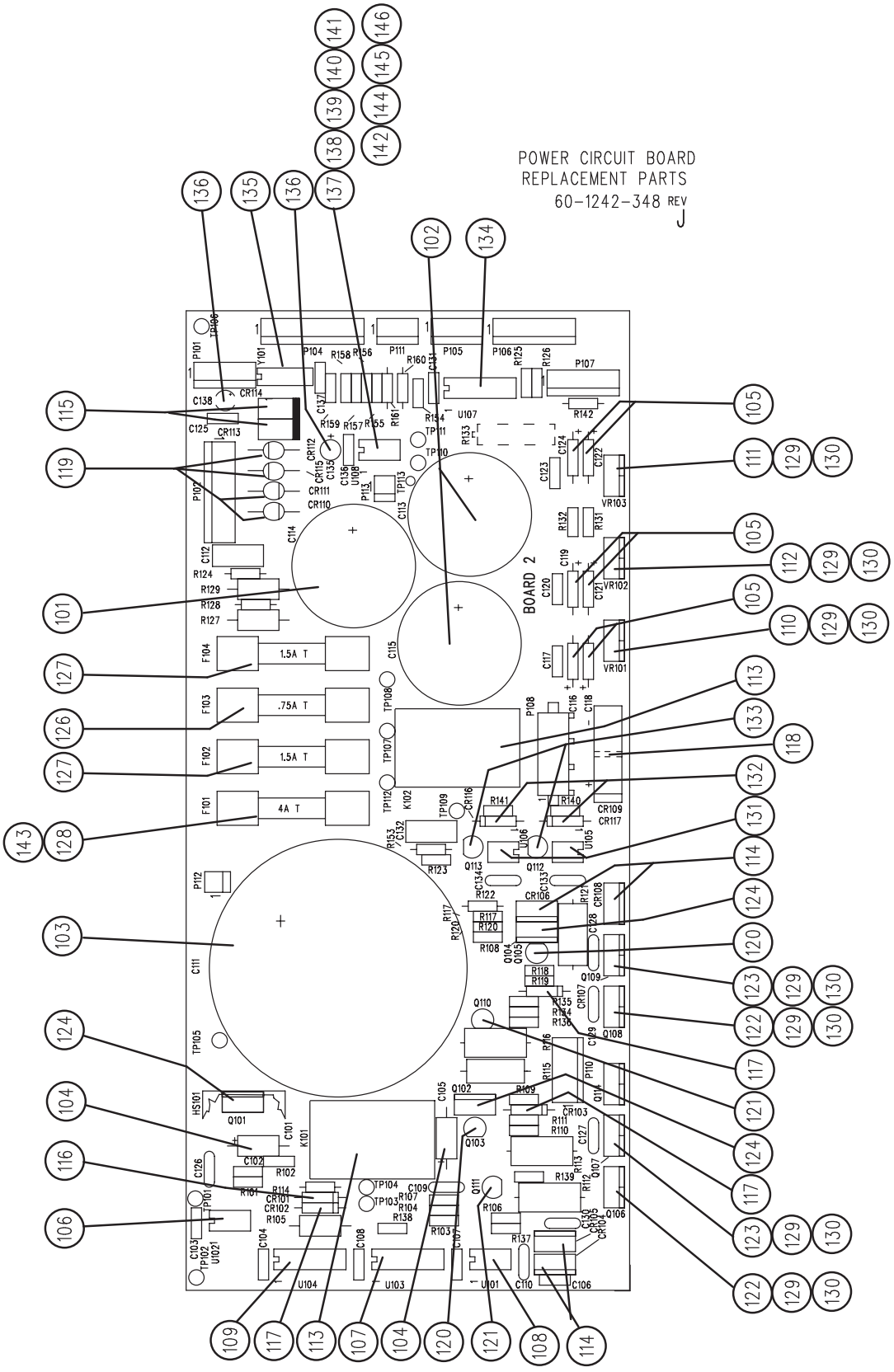
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
51	60-1244-235	CALIBRATED PREAMP ASSY
52	69-1243-465	CYLINDER CAP SEAL
53	60-1243-291	DELRIN PLUG
54	231-2007-04	SET SCREW, 1/4-20 X 1/4, CUP POINT

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.9 Power Circuit Board



REPLACEMENT PART LIST
TELEDYNE ISCO, Inc

POWER CIRCUIT BOARD

DWG NO: 60-1242-348
SHEET: 2 OF 3
REV: J DATE: 110311

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
101	110-4568-01	C114	CAP 6800uF 25VDC
102	110-6333-01	C113 C115	CAP 3300uF 50VDC
103	110-7290-00	C111	CAP 6400uF 150VDC
104	112-5010-00	C101 C105	CAP 2.2uF 20VDC
105	112-7510-00	C116 C118 C119 C121 C122	CAP 1uF 35VDC
		C124	
106	270-0000-01	U102	IC HCPL-2232
107	270-0013-00	U103	IC 4011B
108	270-0129-03	U101	IC LM2903
109	270-2002-00	U104	IC D469
110	279-0200-07	VR101	VR LM7915CT
111	279-0201-05	VR103	VR LM7815C
112	279-0603-01	VR102	VR LM317
113	360-1024-03	K101 K102	RLY SPDT 24VDC 10A
114	400-0151-01	CR104 CR105 CR106 CR108	MUR1515
115	400-0154-01	CR113 CR114	DIO 1N5401
116	400-0914-00	CR101	DIO 1N914
117	400-2152-22	CR102 CR103 CR107	DIO 1N5242B
118	401-0008-00	CR109	KBU8D
119	401-0150-00	CR110 CR111 CR112 CR115	DIO 1N5060
120	402-0237-00	Q103 Q105	XSTR 2N3702
121	402-0237-01	Q110 Q111	XSTR 2N3704
122	402-0640-00	Q106 Q108	XSTR IRF641
123	402-0964-00	Q107 Q109	XSTR IRF9641
124	402-1000-50	Q101 Q102 Q104	XSTR TIP50
126	411-0311-42	F103	FUSE .75A T
127	411-0311-56	F102 F104	FUSE 1.5A T
128	411-0312-70	F101	FUSE 4A T
143	411-0322-75	F101	FUSE 5A FAST-BLO(65HP & 500HP PUMP ONLY)

NOTE: This list subject to change without notice.

REPLACEMENT PART LIST
TELEDYNE ISCO, Inc

POWER CIRCUIT BOARD

DWG NO: 60-1242-348
SHEET: 3 OF 3
REV: J DATE: 110311

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
129	409-9006-00		WSHR NYL DF137A
130	409-9005-03		INSUL SLCON TO220
131	279-0601-04	U105 U106	IC H74A1
132	400-2152-08	CR116 CR117	DIO 1N5234B
133	402-9270-00	Q112 Q113	XSTR 2N7000
134	270-0474-01	U107	IC 74HC14
135	170-1000-15	Y101	XTAL SG-531 1.8432 MHz
136	112-6010-00	C135 C138	CAP 10UF 25V TANT
137	60-1245-151	U108	CODED PUMP ID CHIP 65D, 65HP
138	60-1245-152	U108	CODED PUMP ID CHIP 100DM
139	60-1245-153	U108	CODED PUMP ID CHIP 100DX
140	60-1245-154	U108	CODED PUMP ID CHIP 260D
141	60-1245-155	U108	CODED PUMP ID CHIP 500D
142	60-1245-156	U108	CODED PUMP ID CHIP 1000D
144	410-3000-00	U108	SW SPST X 4 (500HP PUMP ONLY)
145	60-1245-173	U108	CODED PUMP ID CHIP 260HP
146	60-1245-177	U108	CODED PUMP ID CHIP 65DM

NOTE: This list subject to change without notice.

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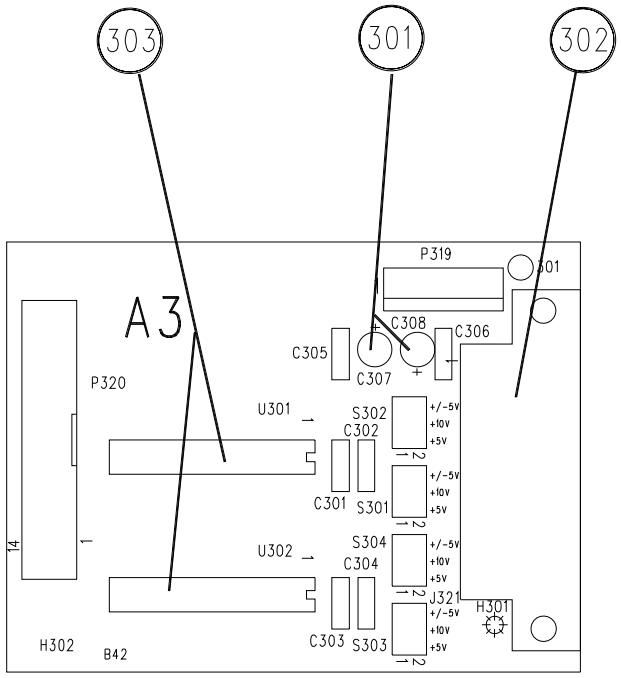
A.1.10 Analog Output Circuit Board



ANALOG OUTPUT CIRCUIT BOARD

REPLACEMENT PART LIST
Isco, Inc

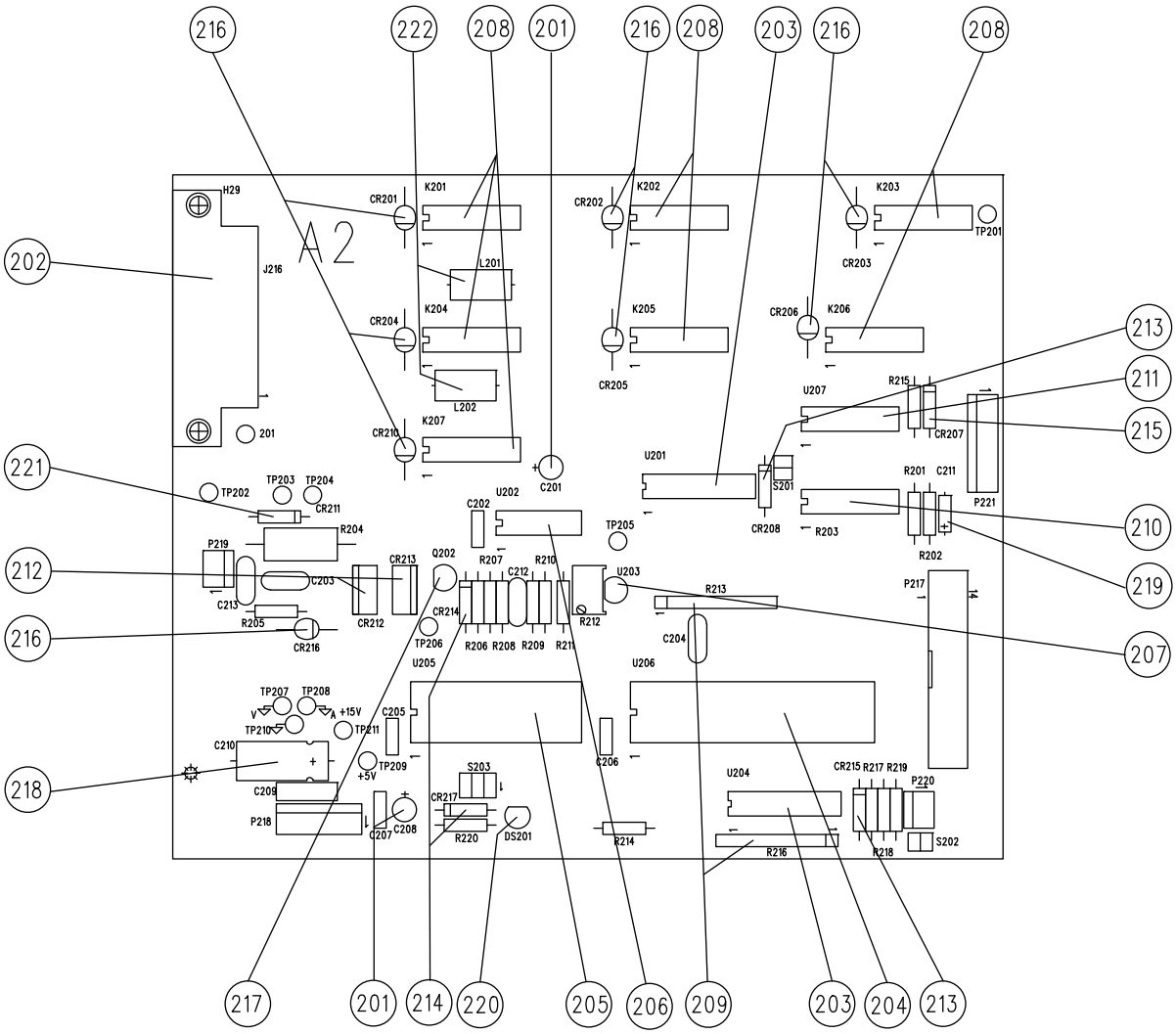
ANALOG OUTPUT CIRCUIT BOARD

DWG NO: 60-1242-275
SHEET: 2 OF 2
REV: DATE: 92050

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
301	112-6010-00	C307 C308	CAP 10uF 25VDC
302	141-9002-26	J321	SKT 25 PIN SUB D RA
303	270-1600-27	U301 U302	IC AD7237

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228-4250.
2. This list subject to change without notice.

A.1.11 Interface Circuit Board



INTERFACE CIRCUIT BOARD

REPLACEMENT PART LIST
Isco, Inc

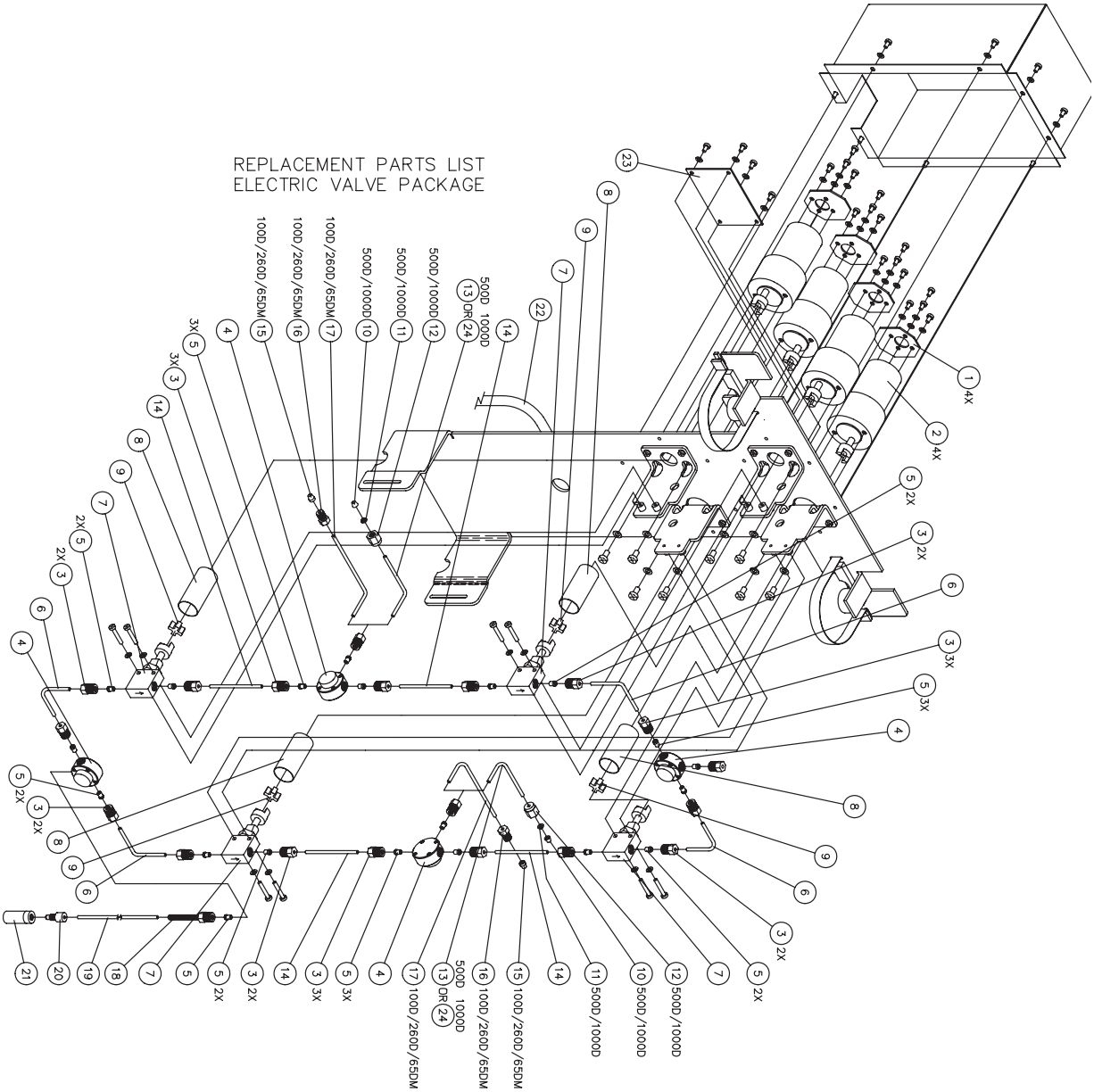
INTERFACE CIRCUIT BOARD

DWG NO: 60-3932-002
SHEET: 2 OF 2
REV: A DATE: 99100

ITEM NO	PART NUMBER	REFERENCE DESIGNATION	DESCRIPTION
201	112-6010-00	C201 C208	CAP 10uF 25VDC
202	141-9002-27	J216	SKT 25 PIN D-SUB RTANG
203	270-0803-01	U201 U204	IC 2803
204	270-1300-37	U206	IC 82C55A-2
205	270-1300-40	U205	IC DS1286
206	270-0103-24	U202	IC LM324
207	279-0205-07	U203	IC VREF 336 2.5V
208	365-3012-00	K201 K202 K203 K204 K205	RLY DPDT 12VDC
		K206 K207	
209	379-5027-50	R213 R216	RES 9 X 2.7K
210	379-5027-51	R203	RES 8 X 2.7K
211	400-0720-00	U207	IC SP720
212	400-0151-01	CR212 CR213	DIO MUR1520
213	400-2022-00	CR208 CR215	DIO ZENER 22V 1N4748A
214	400-2152-08	CR214 CR217	DIO ZENER 6.2V 1N5234B
215	400-2152-11	CR207	DIO ZENER 4.7V 1N5230B
216	401-0150-00	CR201 CR202 CR203 CR204 CR205	DIO 1N5060
		CR206 CR210 CR216	
217	402-9270-00	Q202	XSTR 2N7000
218	110-6310-00	C210	CAP 100uF 50VDC
219	112-5005-00	C211	CAP 1.0uF 20VDC
220	130-0004-00	DS201	LED MV5753 RED
221	400-2152-22	CR211	DIO ZENER 12V 1N5242B
222	60-0854-042	L201 L202	INDUCTOR ASSY

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228-4250.
2. This list subject to change without notice.

A.1.12 Dual Electric Valve Package



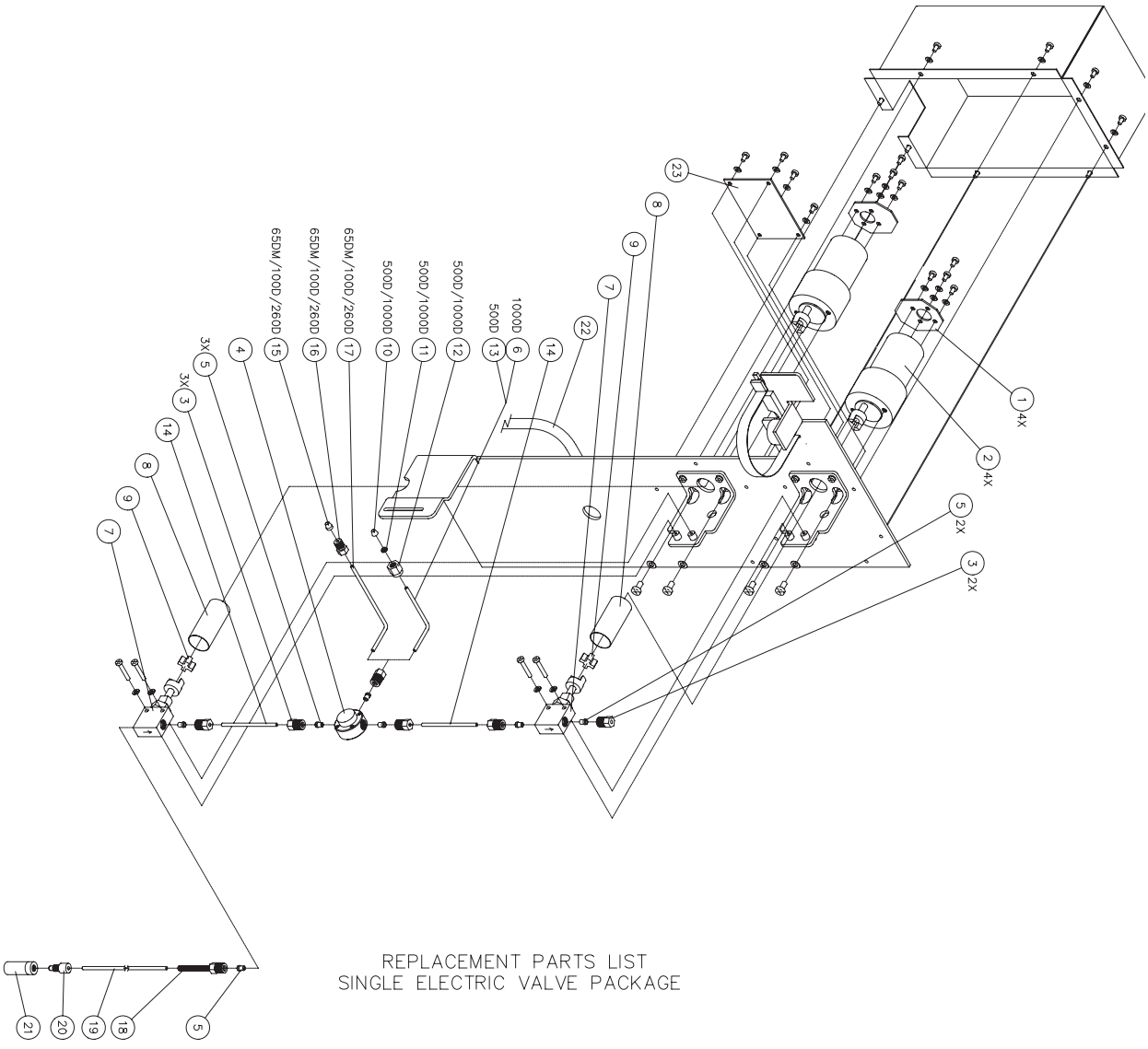
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–337
SHEET: 2 OF 2
REV.: C DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–3934–002	MOTOR CIRCUIT BOARD ASSY
2	60–1243–012	MOTOR ASSY W/ COUPLER
3	209–0169–44	GLAND NUT, 1/8 TUBING, SSI
4	60–1243–737	TEE, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
5	209–0163–53	FERRULE, 1/8 ID, HASTELLOY, SSI
6	60–1243–740	TUBING, 1/8 OD, 1.6 X 1.6
7	60–1244–313	VALVE ASSY, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
8	60–3933–061	COUPLING SHIELD
9	60–3933–010	SPIDER
10	209–0169–10	FRONT FERRULE, 1/8 ID FOR 500D/1000D VALVE PKG
11	209–0169–11	BACK FERRULE, 1/8 ID FOR 500D/1000D VALVE PKG
12	209–0170–04	FITTING NUT, 1/8 TBG FOR 500D/1000D VALVE PKG
13	60–1243–742	TUBING, 1/8 OD, 1.4 X 2.2 FOR 500D VALVE PKG
14	60–1243–746	TUBING, 1/8 OD, 2.6 LONG
15	209–0163–60	FERRULE, 1/8 ID FOR 100D/260D VALVE PKG
16	209–0169–27	NUT, 1/8 TUBING FOR 100D/260D VALVE PKG
17	60–1243–741	TUBING, 1/8 OD, 1.4X3.4 FOR 100D/260D VALVE PKG
18	60–1248–157	NUT ASSY
19	60–1243–557	TUBING, TEFLON, .085 ID, 60 INCHES LONG
20	209–0169–81	MALE NUT, 1/8 TUBING
21	209–0169–80	FILTER, 10 MICRON
22	60–1244–312	MAIN HARNESS
23	69–1244–348	SENSOR CIRCUIT BOARD ASSY
24	69–1243–827	TUBING, 1/8 OD, 1.4 X 1.9 FOR 1000D VALVE PKG

NOTE: 1. This list is subject to change without notice.

A.1.13 Single Electric Valve Package



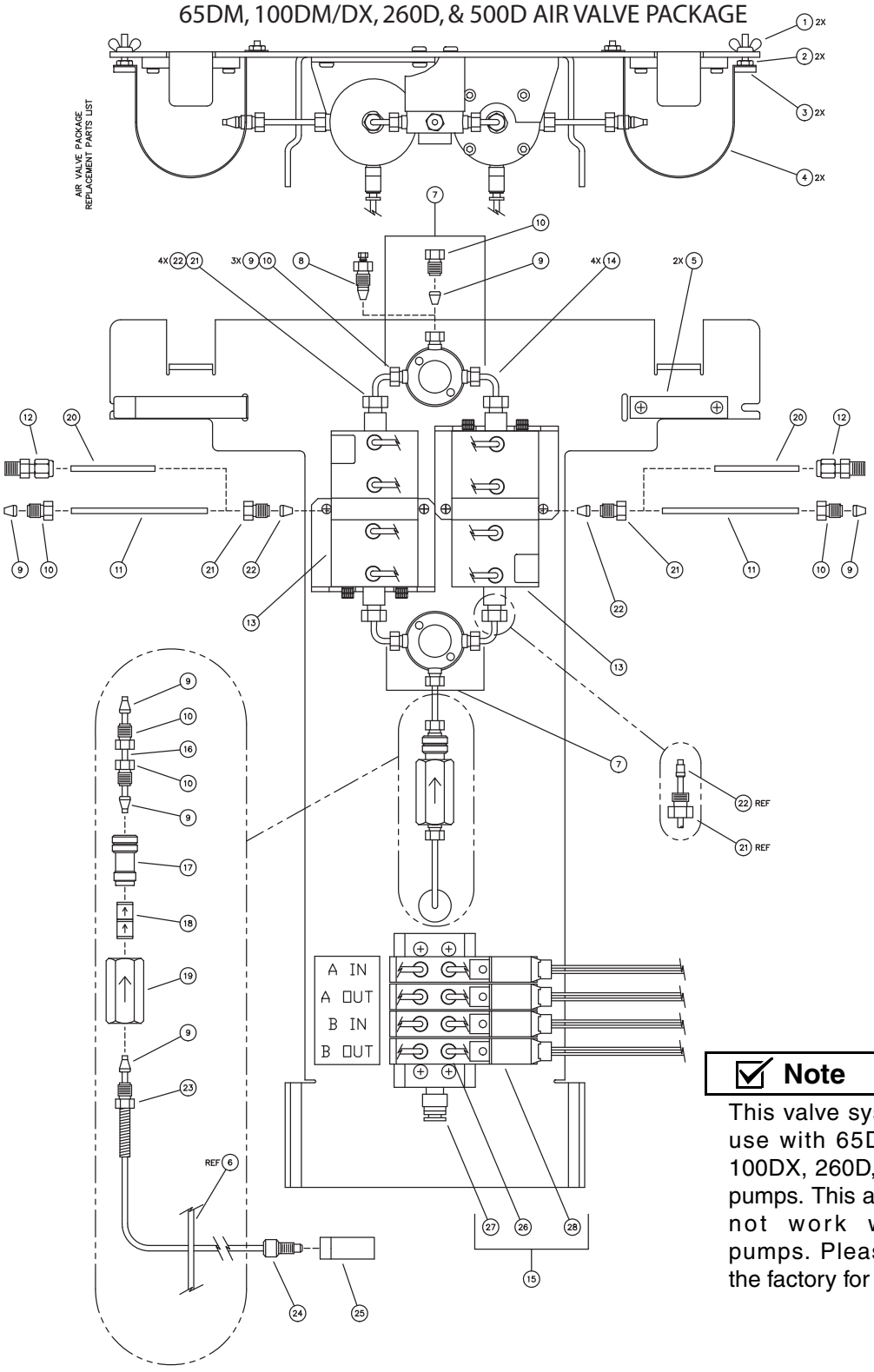
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–867
SHEET: 2 OF 2
REV.: B DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	60–3934–002	MOTOR CIRCUIT BOARD ASSY
2	60–3934–012	MOTOR ASSY W/ COUPLER
3	209–0169–44	GLAND NUT, 1/8 TUBING, SSI
4	60–1243–737	TEE, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
5	209–0163–53	FERRULE, 1/8 ID, HASTELLOY, SSI
6	60–1243–827	TUBING, 1/8 OD, 1.4 X 1.9
7	60–1244–313	VALVE ASSY, 1/8 TUBING (INCLUDES ITEMS 3 & 5)
8	60–3933–061	COUPLING SHIELD
9	60–3933–010	SPIDER
10	209–0169–10	FRONT FERRULE, 1/8 ID FOR 500D VALVE PKG
11	209–0169–11	BACK FERRULE, 1/8 ID FOR 500D VALVE PKG
12	209–0170–04	FITTING NUT, 1/8 TUBING FOR 500D VALVE PKG
13	60–1243–742	TUBING, 1/8 OD, 1.4 X 2.2 FOR 500D VALVE PKG
14	60–1243–746	TUBING, 1/8 OD, 2.6 LONG
15	209–0163–60	FERRULE, 1/8 ID FOR 100D/260D VALVE PKG
16	209–0169–27	NUT, 1/8 TUBING FOR 100D/260D VALVE PKG
17	60–1243–741	TUBING, 1/8 OD, 1.4X3.4 FOR 100D/260D VALVE PKG
18	60–1248–157	NUT ASSY
19	60–1243–557	TUBING, TEFLON, .085 ID, 60 INCHES LONG
20	209–0169–81	MALE NUT, 1/8 TUBING
21	209–0169–80	FILTER, 10 MICRON
22	60–1244–312	MAIN HARNESS
23	69–1244–348	SENSOR CIRCUIT BOARD ASSY

NOTE: 1. This list is subject to change without notice.

A.1.14 SST Dual Air Valve Package for 100/260D/500D



Note

This valve system is for use with 65DM, 100D, 100DX, 260D, and 500D pumps. This air valve will not work with 65D pumps. Please consult the factory for options.

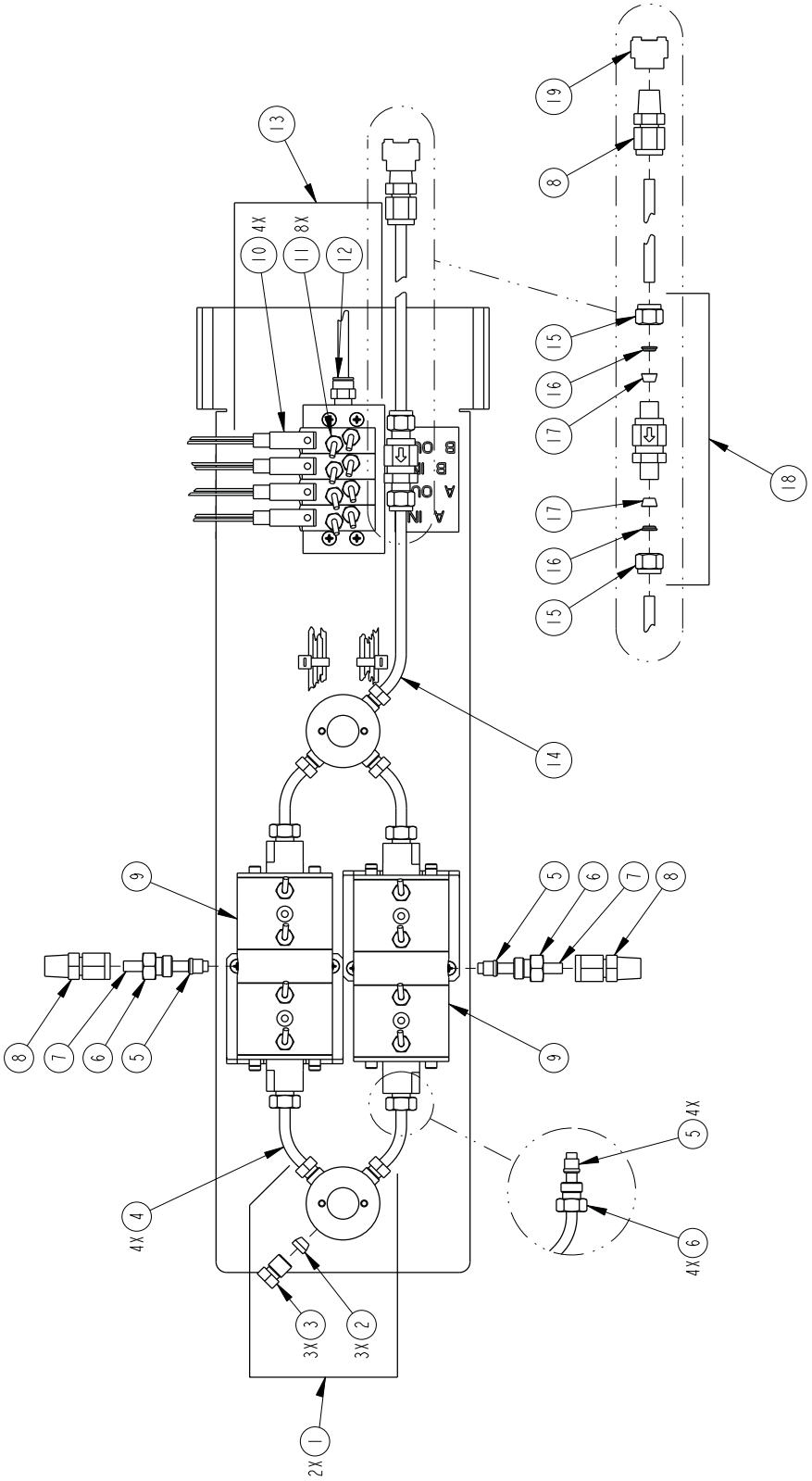
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–227
SHEET: 2 OF 2
REV.: E DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	232–4040–00	WINGNUT
2	232–1140–02	NUT
3	60–1248–101	STRAP MOUNT
4	60–1243–545	STRAP
5	60–1243–553	SPACER BLOCK
6		
7	209–0161–36	1/8 OD TUBING UNION TEE WITH FITTING (VALCO)
8	209–0169–42	1/8 TO 1/16 OD TUBING REDUCER UNION (VALCO)
9	209–0169–41	1/8 OD TUBING FERRULE ZERO VOLUME (VALCO)
10	209–0169–27	1/8 OD TUBING COLUMN NUT (VALCO)
11	60–1243–529	TUBING
12	209–0161–01	1/8 NPT TO 1/8 TUBING MALE CONNECTOR (SWAGELOK)
13	69–1243–572	3 WAY VALVE
14	60–1243–569	TUBING
15	69–1243–574	AIR ACTUATOR
16	60–1243–570	TUBING
17	60–2253–240	CHECK VALVE HOUSING INLET (ANALYTICAL STANDARD INLET)
18	60–3864–010	CHECK VALVE CARTRIDGE
19	60–1243–516	SINGLE CHECK VALVE HOUSING
20	60–1243–544	TUBING
21	209–0161–44	COMPRESSION NUT, SPEEDBITE
22	209–0161–43	1/8 FERRULE, SPEEDBITE
23	60–2258–019	NUT ASSEMBLY
24	209–0169–81	1/8 OD TUBING NUT (UPCHURCH)
25	209–0169–80	10 MICRON FILTER (ANALYTICAL INERT) (UPCHURCH)
26	209–0161–72	1/8 OD TUBE FITTING
27	209–0161–73	1/4 OD TUBE FITTING
28	209–0093–26	SOLENOID VALVE

NOTE: 1. This list is subject to change without notice.

A.1.15 SST Dual Air Valve Package for 1000D



601242404

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

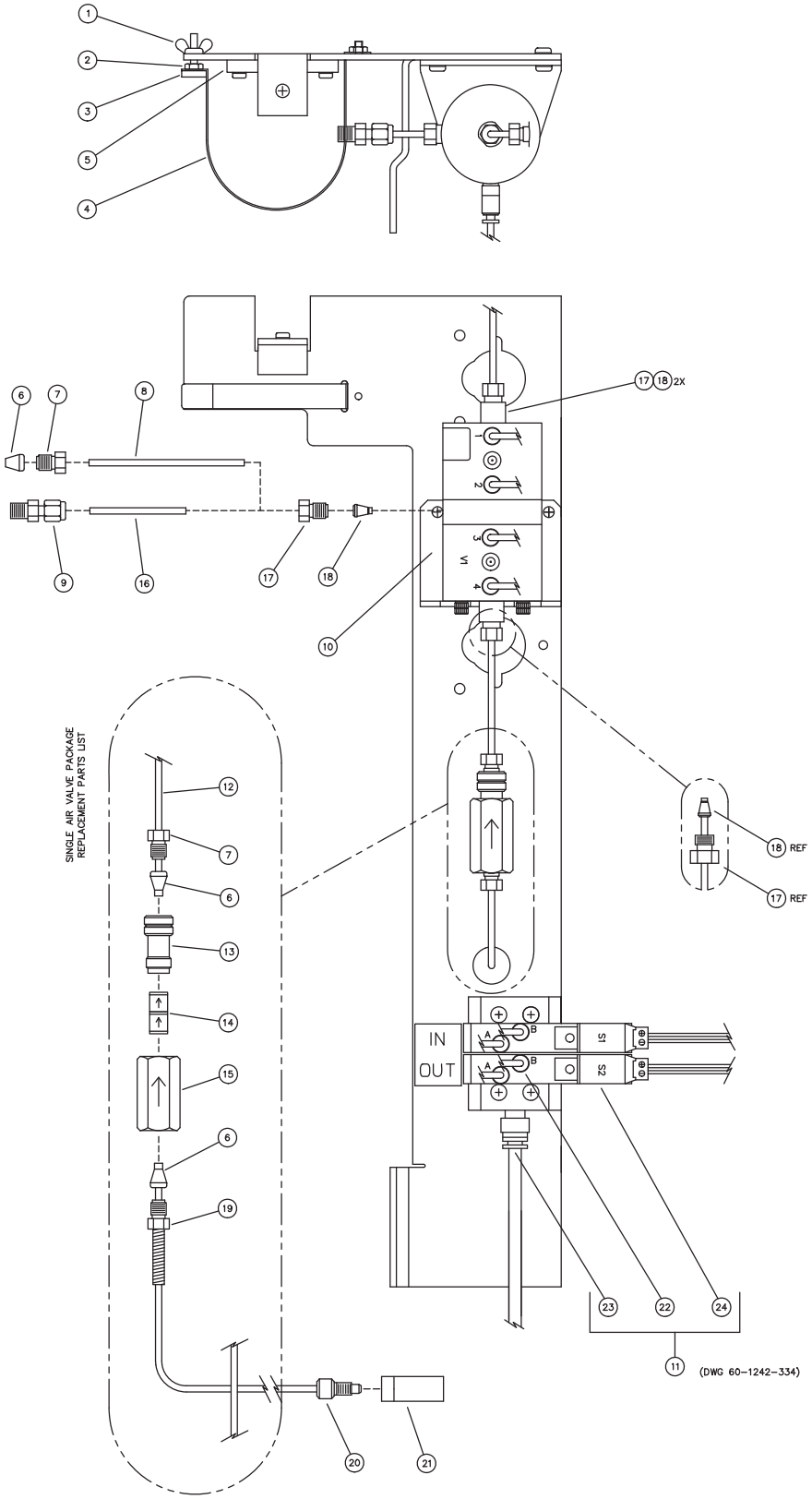
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
1	209016382	1/4 OD SST TUBING TEE W/ FITTINGS (VALCO)
2	209016384	1/4 OD SST TUBING FERRULE (VALCO)
3	209016383	1/4 OD TUBING NUT (VALCO)
4	601243891	TEE TO VALVE STAINLESS STEEL TUBING
5	209016569	1/4 OD HST TUBING FERRULE, SPEEDBITE
6	209016568	1/4 OD GLAND NUT, SPEEDBITE
7	601243893	VALVE TO PUMP STAINLESS STEEL TUBING
8	209016336	1/4 NPT TO 1/4 TUBING SST MALE CONN
9	691243578	3 WAY HASTELLOY VALVE W/ FITTINGS
10	209009326	SOLENOID VALVE
11	209016172	1/8 OD TUBE FITTING
12	209016173	1/8 NPT TO 1/4 OD TUBE FITTING
13	691243574	AIR ACTUATOR
14	601243892	TEE TO CHECK VALVE SST TUBING
15	209016966	1/4 OD TUBING NUT (SWAGELOK)
16	209016369	1/4 SST BACK TBG FERRULE (SWAGELOK)
17	209016368	1/4 SST FRONT TBG FERRULE (SWAGELOK)
18	209016406	CHECK VALVE W/ FITTINGS (SWAGELOK)
19	601248184	INLET FILTER ASSEMBLY

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.16 Single Air Valve Package



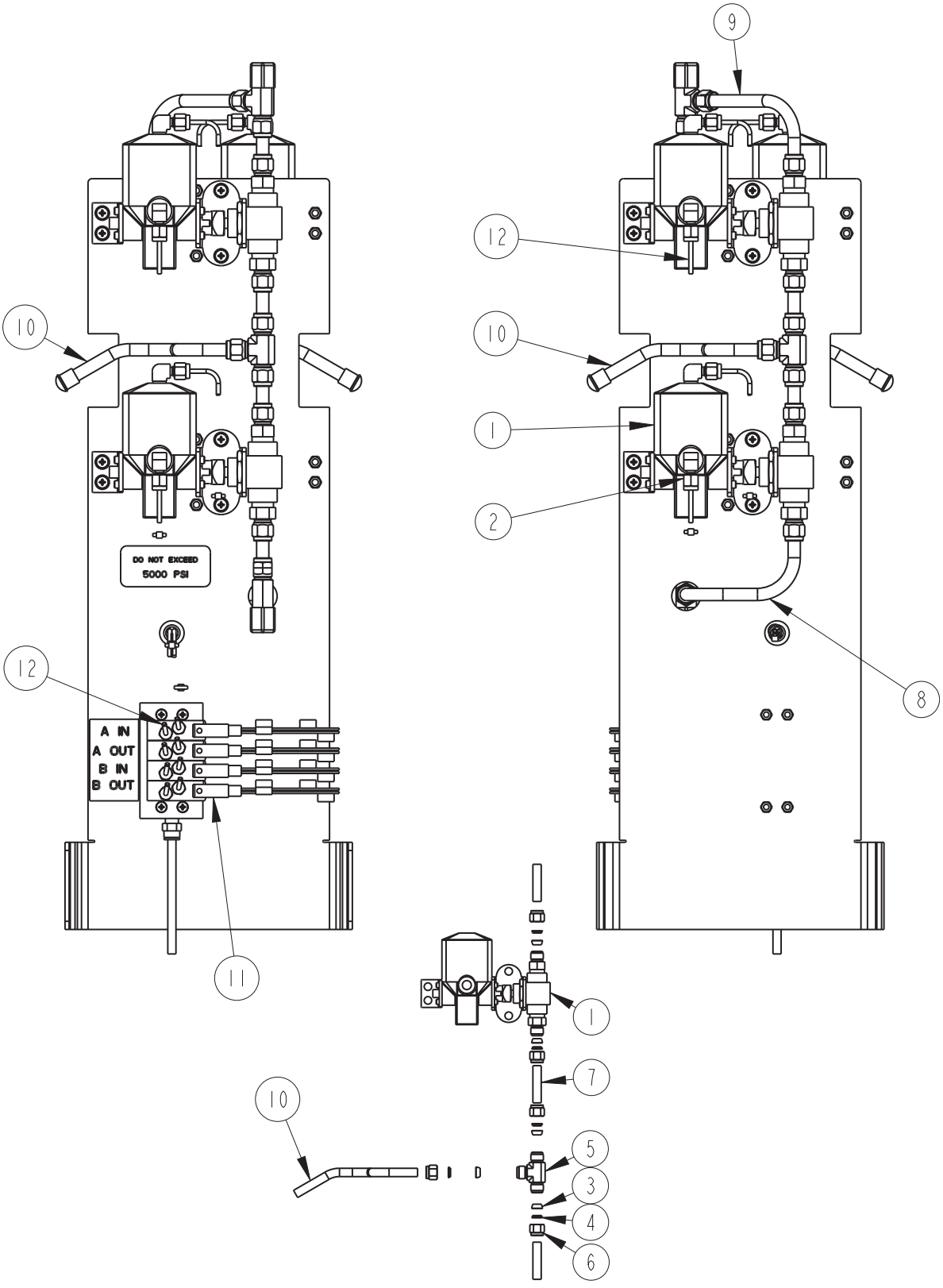
REPLACEMENT PARTS LIST

DWG. NO.: 60–1242–334
SHEET: 2 OF 2
REV.: B DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	232–4040–00	WINGNUT
2	232–1140–02	NUT
3	60–1248–101	STRAP MOUNT
4	60–1243–545	STRAP
5	60–1243–553	SPACER BLOCK
6	209–0169–41	1/8 OD TUBING FERRULE ZERO VOLUME (VALCO)
7	209–0169–27	1/8 OD TUBING COLUMN NUT (VALCO)
8	60–1243–529	TUBING
9	209–0161–01	1/8 NPT TO 1/8 TUBING MALE CONNECTOR (SWAGELOK)
10	69–1243–572	3 WAY VALVE
11	69–1243–729	AIR ACTUATOR
12	60–1243–570	TUBING
13	60–2253–240	CHECK VALVE HOUSING INLET (ANALYTICAL STANDARD INLET)
14	60–3864–010	CHECK VALVE CARTRIDGE
15	60–1243–516	SINGLE CHECK VALVE HOUSING
16	60–1243–544	TUBING
17	209–0161–44	COMPRESSION NUT, SPEEDBITE
18	209–0161–43	1/8 FERRULE, SPEEDBITE
19	60–2258–019	NUT ASSEMBLY
20	209–0169–81	1/8 OD TUBING NUT (UPCHURCH)
21	209–0169–80	10 MICRON FILTER (ANALYTICAL INERT) (UPCHURCH)
22	209–0161–72	1/8 OD TUBE FITTING
23	209–0161–73	1/4 OD TUBE FITTING
24	209–0093–26	SOLENOID VALVE

NOTE: 1. This list is subject to change without notice.

A.1.17 Dual Air Valve Package for 500HPx



601242974

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

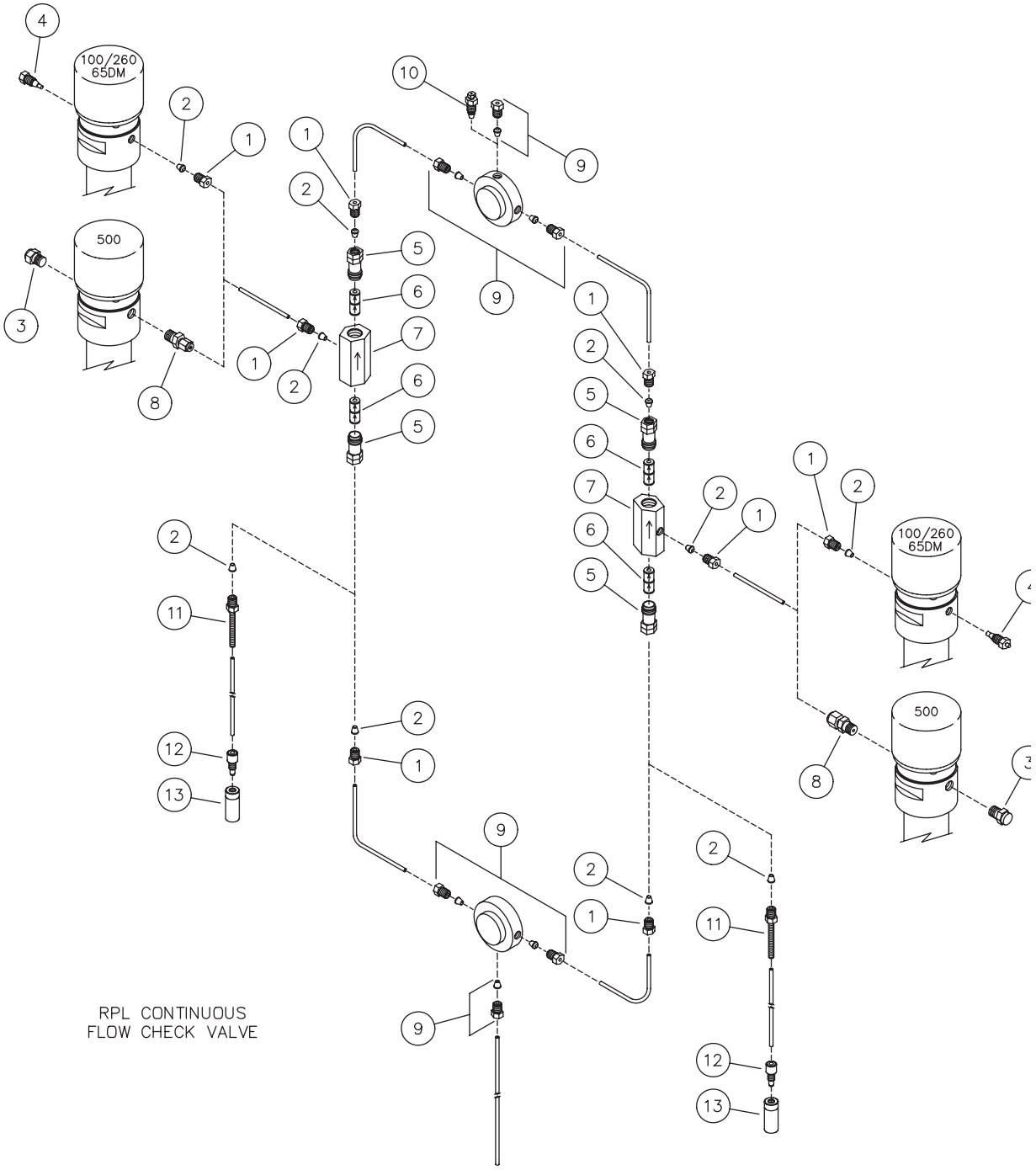
REV:

TELEDYNE ISCO

ITEM NO.	PART NUMBER	DESCRIPTION
1	209009404	2-WAY BALL VALVE
2	209016998	MALE ELBOW CONNECTOR, .12 TUBING
3	209016370	3/8" FRONT TUBING FERRULE
4	209016371	3/8" BACK TUBING FERRULE
5	209016560	3/8" TEE
6	209016611	3/8" TUBE FITTING NUT
7	605363210	INTERMEDIATE TUBE
8	605363211	LOWER CROSSOVER TUBE
9	605363212	UPPER CROSSOVER TUBE
10	605363213	PUMP TUBE
11	691243574	AIR ACTUATOR
12	023050403	1/8" AIR LINE TUBING

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

A.1.18 Dual Check Valve Package for 100/260/500D



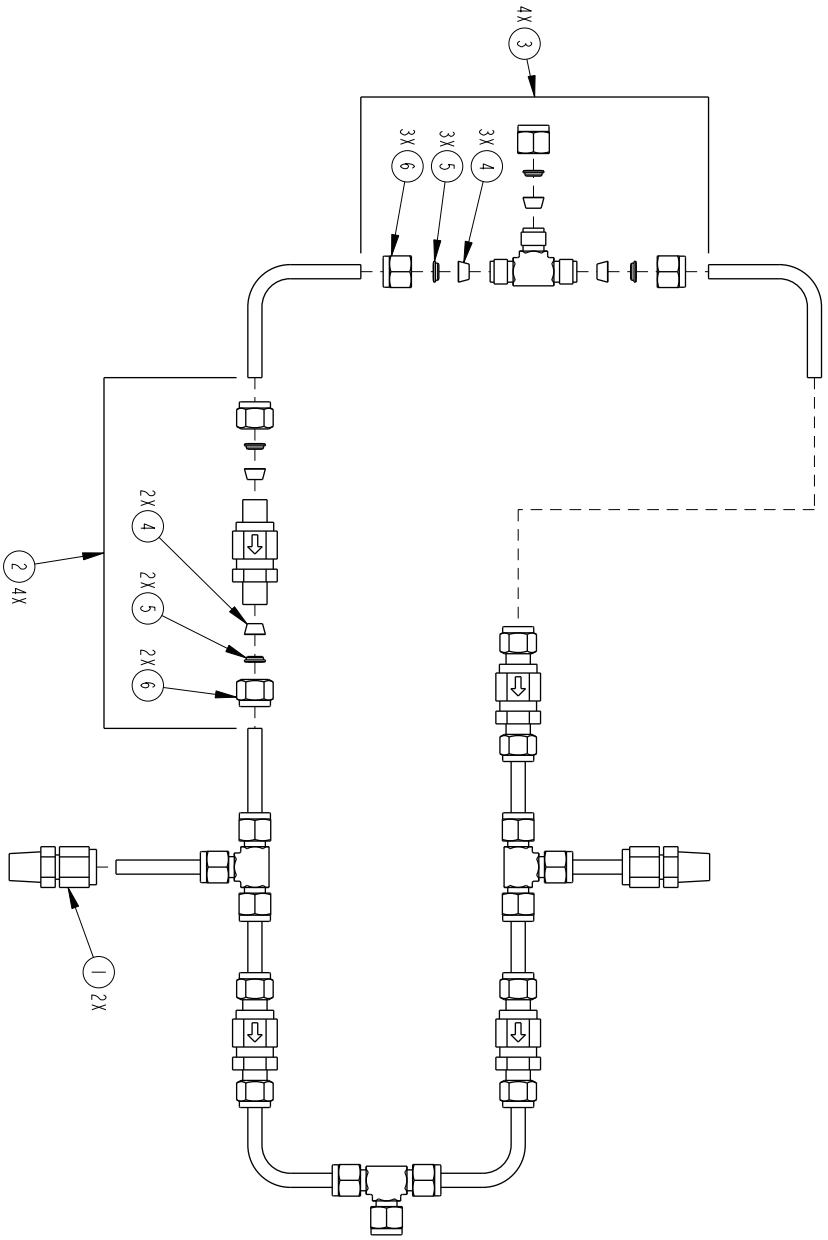
REPLACEMENT PARTS LIST
Isco, Inc.

DWG. NO.: 60–1242–239
SHEET: 2 OF 2
REV.: D DATE: 110311

ITEM NO.	PART NUMBER	DESCRIPTION
1	209–0169–27	NUT
2	209–0169–41	FERRULE
3	209–0168–00	PIPE PLUG
4	209–0166–80	PLUG 1/8 SST HP
5	60–2253–240	CHECK VALVE HOUSING
6	60–3864–010	CHECK VALVE CARTRIDGE
7	60–1243–517	DOUBLE CHECK VALVE HOUSING
8	209–0161–01	MALE CONNECTOR
9	209–0161–36	1/8 UNION TEE
10	209–0169–42	TUBING REDUCER CONNECTOR
11	60–2258–019	NUT ASSEMBLY
12	209–0169–81	TUBING NUT
13	209–0169–80	FILTER

Note: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228–4250
2. This list is subject to change without notice.

A.1.19 Dual Check Valve Package for 1000D



REPLACEMENT PARTS LIST,
DUAL CHECK VALVE PKG, 1000D

605362011

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

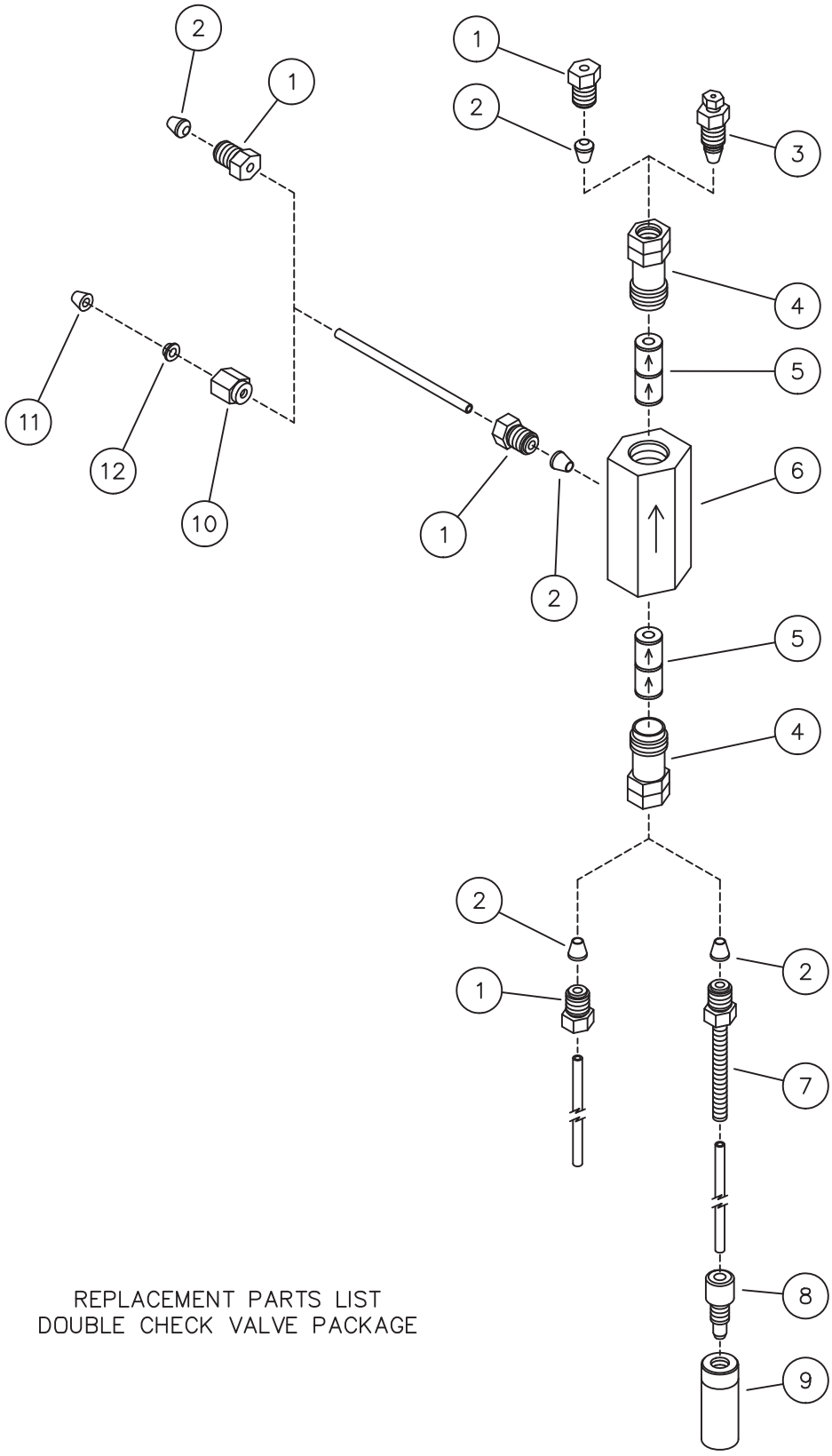
REV:

TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
1	209-0163-36	1/4 NPT TO 1/4 TBG SST MALE CONN
2	209-0164-06	CHECK VALVE W/ FITTINGS (SWAGELOK)
3	209-0168-15	1/4 SST TBG TEE W/ FITTING (SWAGELOK)
4	209-0163-68	1/4 SST FRONT TBG FERRULE (SWAGELOK)
5	209-0163-69	1/4 SST BACK TBG FERRULE (SWAGELOK)
6	209-0169-66	1/4 OD TUBING NUT (SWAGELOK)

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

A.1.20 Single Check Valve Package



REPLACEMENT PARTS LIST
Isco, Inc.

DWG. NO.: 60–1242–249
SHEET: 2 OF 2
REV.: C DATE: 03122

ITEM NO.	PART NUMBER	DESCRIPTION
1	209–0169–27	NUT
2	209–0169–41	FERRULE
3	209–0169–42	TUBING REDUCER CONNECTOR
4	60–2253–240	CV HOUSING INLET (ANALYTICAL STANDARD INERT)
5	60–3864–010	CHECK VALVE CARTRIDGE
6	60–1243–517	DOUBLE CV HOUSING
7	60–2258–019	NUT ASSY
8	209–0169–81	TUBING NUT
9	209–0169–80	FILTER (ANALYTICAL STANDARD INERT)
10	209–0169–00	NUT
11	209–0169–10	FRONT FERRULE
12	209–0169–11	BACK FERRULE

Note: 1. For current prices and quotations on parts, contact Isco Service Department, (800) 228–4250
2. This list is subject to change without notice.

D Series Syringe Pumps

Appendix B Continuous Flow Introduction, Installation, and Operation for 30D

B.1 Introduction

A D Series continuous flow pumping system consists of two syringe pumps and a valve accessory package regulated by one controller. This system allows you to continuously deliver liquefied gas or liquid under constant flow or constant pressure mode.

Continuous flow can be used in either of two modes: continuous constant pressure or continuous constant flow. Both of these modes assume positive displacement of the piston.

Before programming continuous flow, appropriate valves must be connected, the pumps must contain fluid, and there must be back pressure for operation.

B.2 Continuous Flow Air Valves

Air valves generally open and close faster and are less prone to error and component wear, making them suitable for industrial use and other applications where the system will be constantly running; however, they require a user-supplied pressurized air source of 80 to 115 psi (5.5 to 7.9 bar).

Air Valve Package Number

A30D	62-1247-114

☑ Note

Air valves can only be used with pumps A and B.

Table B-1 Continuous Flow Technical Specifications-Air Valves:	
Pressure fluctuation at switch over	34.5 bar at system backpressures from 500 psi (34.5 bar) to the single pump maximum.
Minimum	50.76 psi (3.5 bar)
Maximum system back pressure	The single pump maximum. Valves rated to 30,000 psi (2068 bar)
Air supply source pressure	80 to 115 psi (5.5 to 7.9 bar)
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate.	A30D 14.3
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	0 to 40°C
Wetted materials in valve packages:	
Air valves	Hastelloy, PEEK, and PTFE
Tubing and fittings	SS316, gold

B.2.1 Dual Air Valve Installation

To install the air valve package (refer to Figure 5-3, 5-5, or B-1, depending on your pump model):

1. Position the valve bases 1.3 cm apart.
2. Use the plugs to stopper the ports which will not be connected.

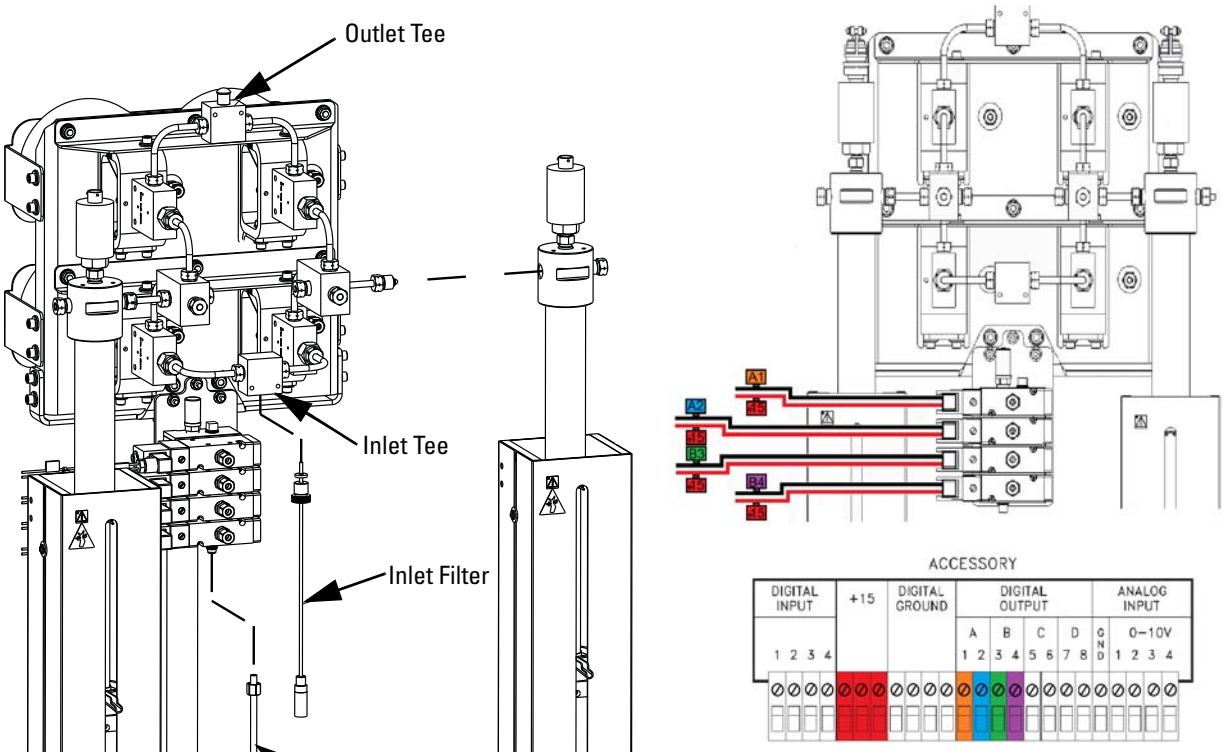
⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 2068 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Loosely attach the tubing lengths from the valve assembly to the pumps.
4. Install the four panhead screws on bottom of the bracket.

Plumbing connections

5. Tighten the tubing nuts.
6. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.



Wire Pair Conversion Table for A-B Pump Pair		
A-B Pump Wire Pair	**Digital Output**	**+15 Wires**
A1	A1	+15
A2	A2	+15
B3	B3	+15
B4	B4	+15

Figure B-1 Air valve installation for 30D pump

B.3 Continuous Flow Electric Valves

Electric valves, which provide the best positive valve closure, are most commonly used in liquefied gas applications. Electric valves require the pump controller to be equipped with the valve driver board.

Electric Valve Package Number

E30D 62-1247-113

> ☑ ***Note***
>
> Electrical valves can only be used with pumps A and B.

B.3.1 Technical Specifications

Dual system maximum flow rates under optimal conditions are approximately 65% of the max flow rate for each pump model.

Table B-2 Continuous Flow Technical Specifications-Electric Valves:

Pressure fluctuation at switch over	3.44 bar, at system back pressures from 6.9 bar to the single pump maximum. Higher fluctuation occurs at pressures below 6.9 bar.
Minimum	3.5 bar
Maximum system back pressure	The single pump maximum. Valves rated to 2068 bar
Maximum flow rate (ml/min)	
Liquids: 65% of the single pump maximum rate (excluding E1000 systems).	E30D 14.3
Liquefied gases	45% of the single pump maximum rate. Cylinder cooling jackets should be used to obtain this rate.
Temperature range	5 to 40° C
Wetted materials in valve package:	
Tubing and fittings	SS316, gold

B.3.2 Dual Electric Valve Installation

To install the electric valve package (refer to Figure B-2 on the following page):

1. Position the valve bases 1.3 cm apart.
2. Use the plugs to stopper the ports that will not be connected.

⚠ DANGER

RISK OF INJURY. THE PRESSURE PRODUCED COULD BE 2068 BAR. PLEASE UTILIZE APPROPRIATE TUBING AND CONNECTIONS NOTED IN THE MANUAL.

3. Loosely attach the tubing lengths from the valve assembly to the pumps.
4. Install the four bracket panhead screws on the bottom of the bracket.

Plumbing connections

5. Tighten the tubing nuts.
6. Connect the inlet tube to the supply reservoir. Connect the outlet tee to your apparatus.

Electrical connections

7. Connect the DB-25 cable to the controller rear panel “electric valves” connector (Figure B-2).

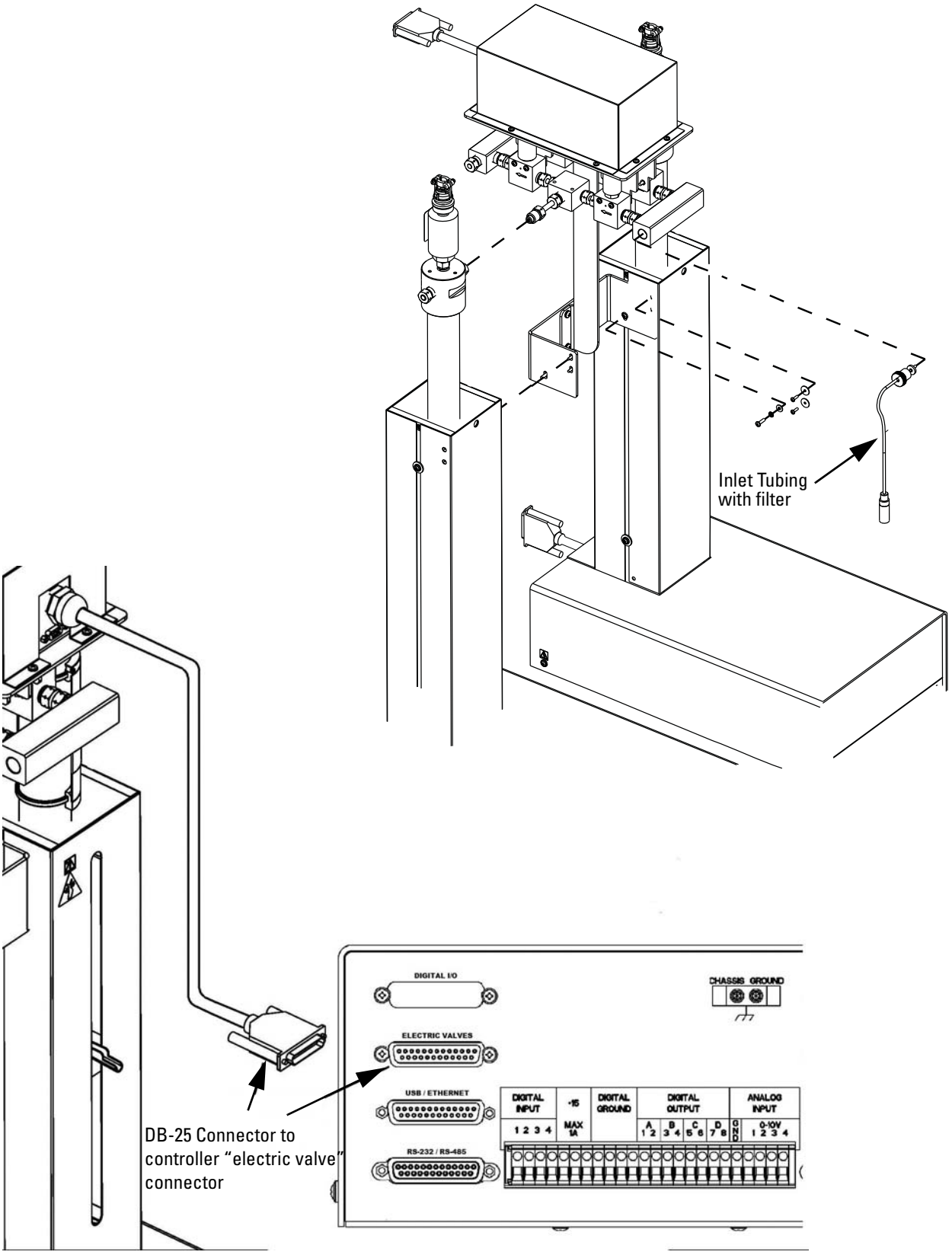


Figure B-2 Electric valve installation

B.4 User Supplied Valves

Users may also choose to supply their own valves. The following information is necessary to choose the appropriate valves to work with Teledyne Isco Continuous Flow software.

- Check valves

  Do not use spring-loaded check valves if refilling at atmospheric pressure; the pump seals are not designed to draw against a vacuum.

- Powered valves

  These are electrically triggered from the pump controller and could be air or electrically actuated. Digital outputs 1-4 provide signals for control of four two-way valves. One wire for each valve is connected to its specific connector on the rear of the controller. A second wire for each valve connects to ground. The signal provided is an open collector which functions as a switch open for closure of the fluid path. A switch closure (low) signals opening of the fluid path.

Table B-3 shows the relationship between the digital output, pump valve location, and the fluid path status for the ACCESS CTRL connections. Refer to the accessory control connections on the rear panel of the pump controller.

Table B-3 Accessory Control Digital Outputs

Digital Output	Pump Valve Location	Fluid Path Status
1	A	Inlet (open or closed)
2	A	Outlet (open or closed)
3	B	Inlet (open or closed)
4	B	Outlet (open or closed)
5	C	Inlet (open or closed)
6	C	Outlet (open or closed)
7	D	Inlet (open or closed)
8	D	Outlet (open or closed)

Alternate connections can be made to drive low power 12-15 V relays or electric valves. Assume two wires per relay or valve. The first wire is connected to the appropriate digital output on the back of the pump controller. The second wire can be connected to the +15 V connector, to supply a maximum of 200 mA for switching of relays or valves. Observe correct polarity if the valve or relay is polarized.

B.5 Continuous Flow Mode

Once your valve package has been properly installed and you have ensured that fluid connections are leak-free, the system is ready for operation.

> ☑ ***Note***
>
> Teledyne Isco convention is to name the pumps "pump A" and "pump B," reading from left to right.

Before running in continuous flow mode, become familiar with independent mode, which allows the controller to operate two pumps independently and simultaneously. You must operate the two pumps manually for initial setup, *i.e.* refill and purging of air. If the Teledyne Isco air valve package is used, the air valves are switched through ACCESS CTRL. When air valves are used, lights on the air valve actuator indicate which valves are open.

> ☑ ***Note***
>
> The 30D will not work in Receive Mode.

Table B-4 Key functions in the Multi-pump Mode

Key	Display Option	Description
A	NORMAL	Uses a finer (slower) pressure match control when switching from one pump to the other.
	FAST	Uses a coarser (faster) pressure match control when switching from one pump to the other.
B	NORMAL PRESS	Uses pressure matching when switching from one pump to the other
	LOW PRESS	Uses no pressure matching when switching from one pump to the other.
C	DELIVER	Sets the pump into the delivery mode of operation.
6	OTHER OPTIONS	Sets the fill and refill marks that are used with both continuous flow modes. Sets the NCV feature On/Off. See Section B.5.4.

B.5.1 Defining Operation

Select Pump – This menu allows you to select any pump to display its run screen (program and operation data) and to make program changes.

Valve specification – To prevent pressure fluctuation at switchover, you must specify the type of valve package you are using.

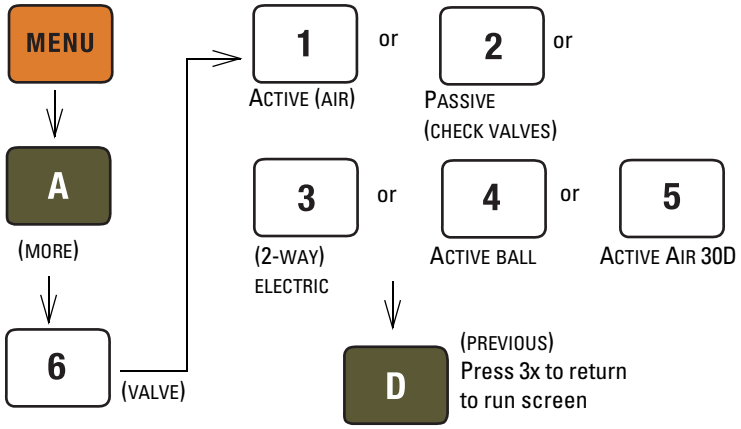


Figure B-3 Keystrokes to specify valve type

Volume totalizer – The total volume delivered is displayed in liters at the top right corner of the screen. Refer to the figure below to reset the volume totalizer to zero.

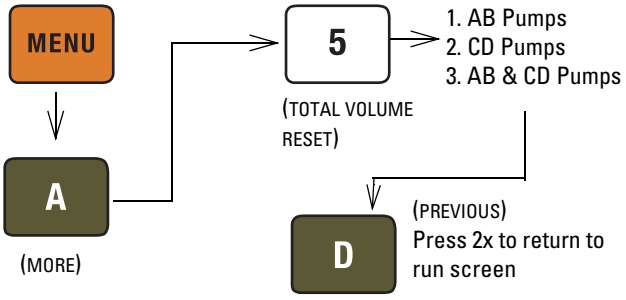


Figure B-4 Keystrokes to reset volume totalizer

B.5.2 Constant Flow Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

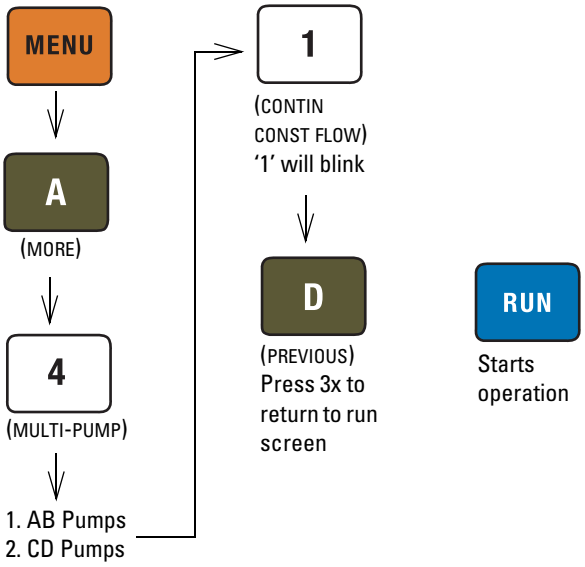


Figure B-5 Keystrokes to set up constant flow

B.5.3 Constant Pressure Mode

Continuous flow mode is found under the multi-pump options on Menu 2. Once you have accessed the multi-pump options, you may select Constant Flow mode or Constant Pressure mode.

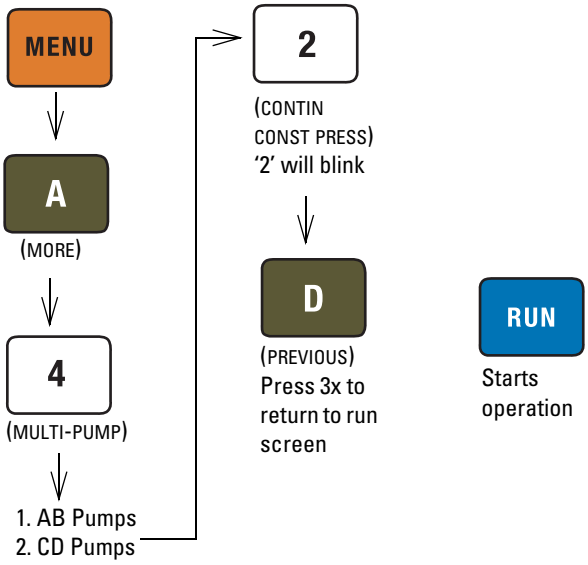


Figure B-6 Keystrokes to set up constant pressure

B.5.4 No Check Valve

To limit fluid backflow from the pump to the supply reservoir one of two approaches is generally used. Either a check valve is installed in the supply line or the NO CHECK VALVE (NCV) software feature is enabled on the controller.

The NO CHECK VALVE (NCV) feature controls the opening of the inlet valves such that, just prior to refill, the pump is depressurized to a user-specified value (pressure point) or until a user-specified time out period (time point). This reduces pressure in the cylinder before the inlet valve is opened.

The NCV software feature is disabled by default; however, if no check valve is installed on the supply line, it is recommended that this feature is enabled.

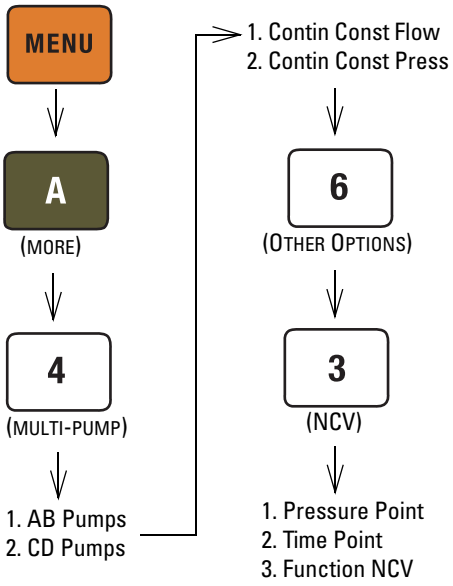


Figure B-7 Keystrokes to set up No Check Valve

B.5.5 To Run or Stop

This menu setting allows the operator to run or stop both pairs of pumps simultaneous.

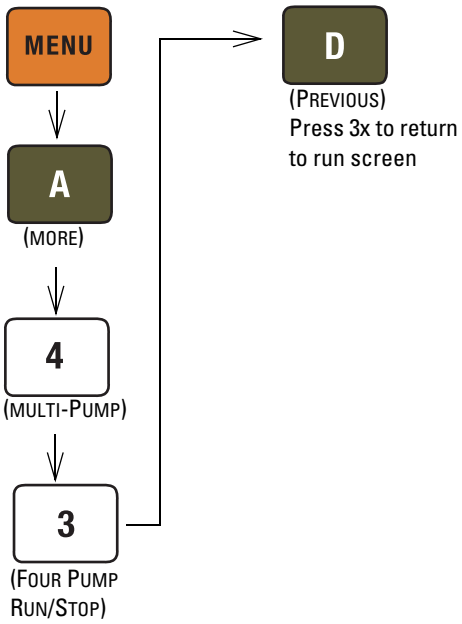


Figure B-8 Keystrokes to Run or Stop the pumps

> **Note**
> Before pressing RUN, ensure that ON CONT FLOW is displayed on the screen, and that the set flow rate/pressure is correct.

Always verify the valve settings before running a program. If a controller is reset or moved to a different power source, it will revert back to default settings (Active).

B.5.6 Tips for Running Continuous Flow

Liquids Checklist:

1. Degas liquids if appropriate.
2. Purge air from the system:
   a. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
   b. Route the outlet to waste or reservoir and press RUN. Press STOP when fluid comes out of the outlet.
   c. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
   d. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
   e. Connect the outlet tubing and fill each pump once more.
3. Reset total volume (see Figure B-4).

Liquefied Gases Checklist:

1. Open the valves to atmosphere by pressing ACC CTRL, then selecting each valve to open.
2. Zero the pressure in each pump by pressing ZERO PRESS and selecting each pump to zero.
3. Fill both pumps completely by pressing REFILL and selecting each pump to fill.
4. Pressurize both pumps by pressing RAPID PRESS. Maximum flow rate and target pressure value will be displayed. Press D to continue pressurization.
5. Reset total volume (see Figure B-4).

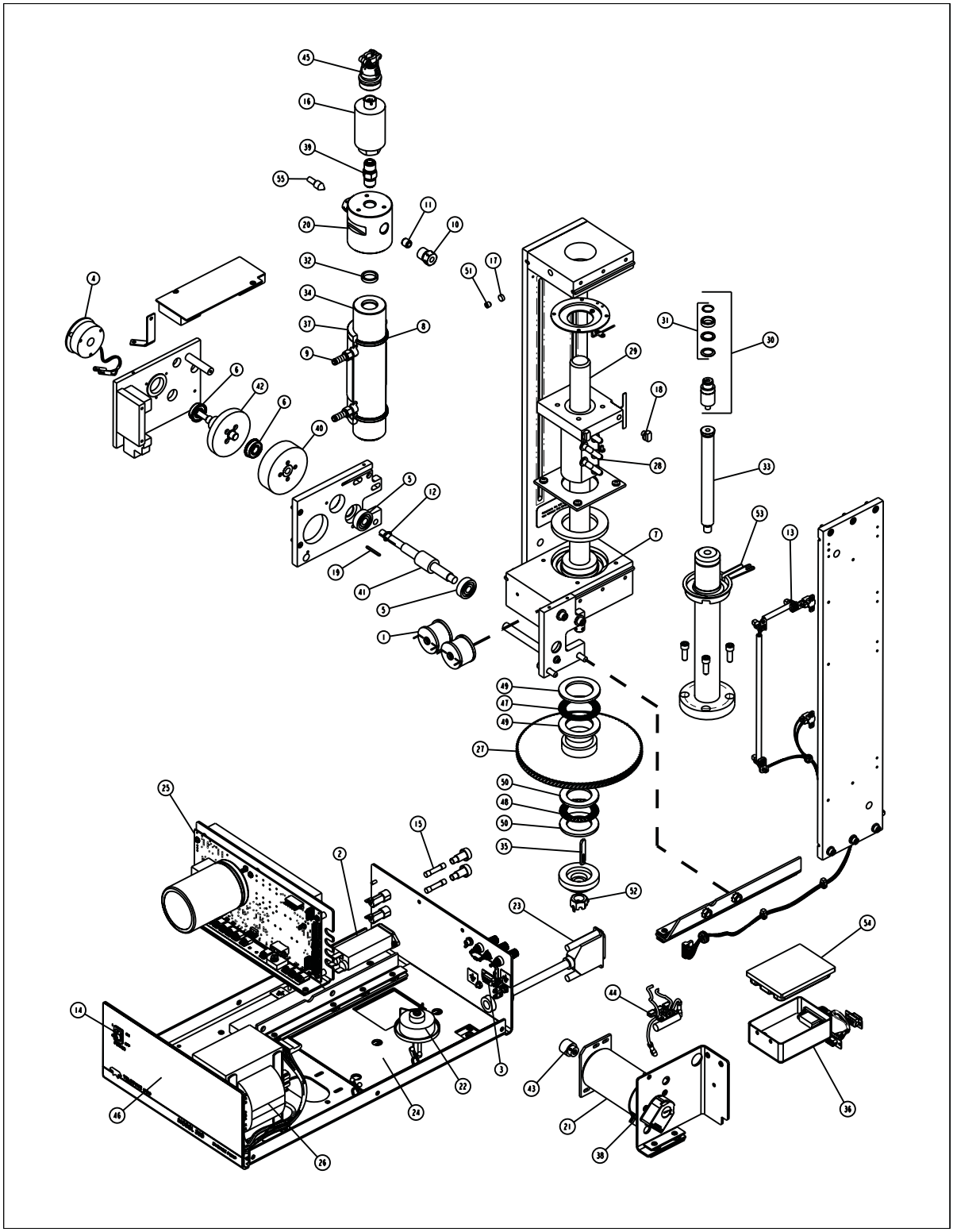
Equilibration – When the pumps begin running, the system will go through an equilibration phase, during which both pumps must be full and delivering fluid.

Additional guidelines – Please become familiar with the following guidelines:

- Pressure limits for continuous constant flow mode are set by the limits of pump A for the A-B pair and pump C for the C-D pair.
- Temperature changes can cause pressure fluctuations. For available temperature control options, contact Teledyne Isco.
- For correct overpressure response, shutdown must be set to ON under PUMP LIMIT options.
- Enter the same refill rate separately for pumps A, B, C, and D.
  The refill rate should always be as high as possible to allow time for refill and repressurization before the next switchover.

B.6 Replacement Parts List

B.6.1 30D Pump



601262101

REPLACEMENT PARTS LIST

SHEET: 2 OF 3

TELEDYNE ISCO

REV: F

ITEM NO.	PART NUMER	DESCRIPTION
1	120000701	CHOKE
2	120001300	EMI POWER FILTER
3	141400102	SKT D-SUB 9 CONT
4	150000601	BRK FLSF RVS 24V KB
5	201032900	BRG CYL.3541D1.00D KB
6	201133700	BRG CYL .381D.880D KB
7	201429902	BRG THR 351DX720D, INDIVIDUAL (ORDER QTY: 2)
8	202206223	O RING 1.609ID.139
9	209016100	CONN MALE .12 HOSE
10	209016402	GLAND F250C 30VM
11	209016403	CLR F250C 30VM
12	233613600	WSHR WV .397 ID
13	691244415	UNIVERSAL SENSOR HARNESS
14	410730401	SW RKR DPDT CSA 4A KB
15	411461264	FU 1.6A 250 SB 3AB (234 VOLT)
15	411461271	FU 3.2A 250 SB 3AB (100 VOLT & 117 VOLT)
16	460010119	XDCR PRESS 0-30,000 PSI
17	601243291	DELRIN PLUG
18	601243348	SLIDE THRUST BEARING
19	601243610	GEAR TRAIN KEY
20	601243876	CYLINDER CAP, 65ML
21	601244184	MOTOR ASSEMBLY WITH ENCODER AND GEAR
22	601244236	LUBE WHEEL ASSEMBLY
23	601244323	HARN MN PMP - ENCD KB
24	601243981	GEAR TRAIN SOAK PAD
25	601249130	30D CBA REPLACEMENT KIT
26	601244493	XFRMR ASSY,30D
27	601245168	WORM GEAR MOD
28	601248116	BALL NUT ASSY
29	601248127	BALL SCREW ASSY
30	601249128	RPLCMNT KIT,30D PISTON ASSY
31	601249129	RPLCMNT KIT,30D PISTON SEAL
32	601263098	CYLINDER CAP SEAL, 30ML
33	601263144	PUSH ROD, 30ML
34	601263105	CYLINDER,30ML

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

601262101

REPLACEMENT PARTS LIST

SHEET: 3 OF 3

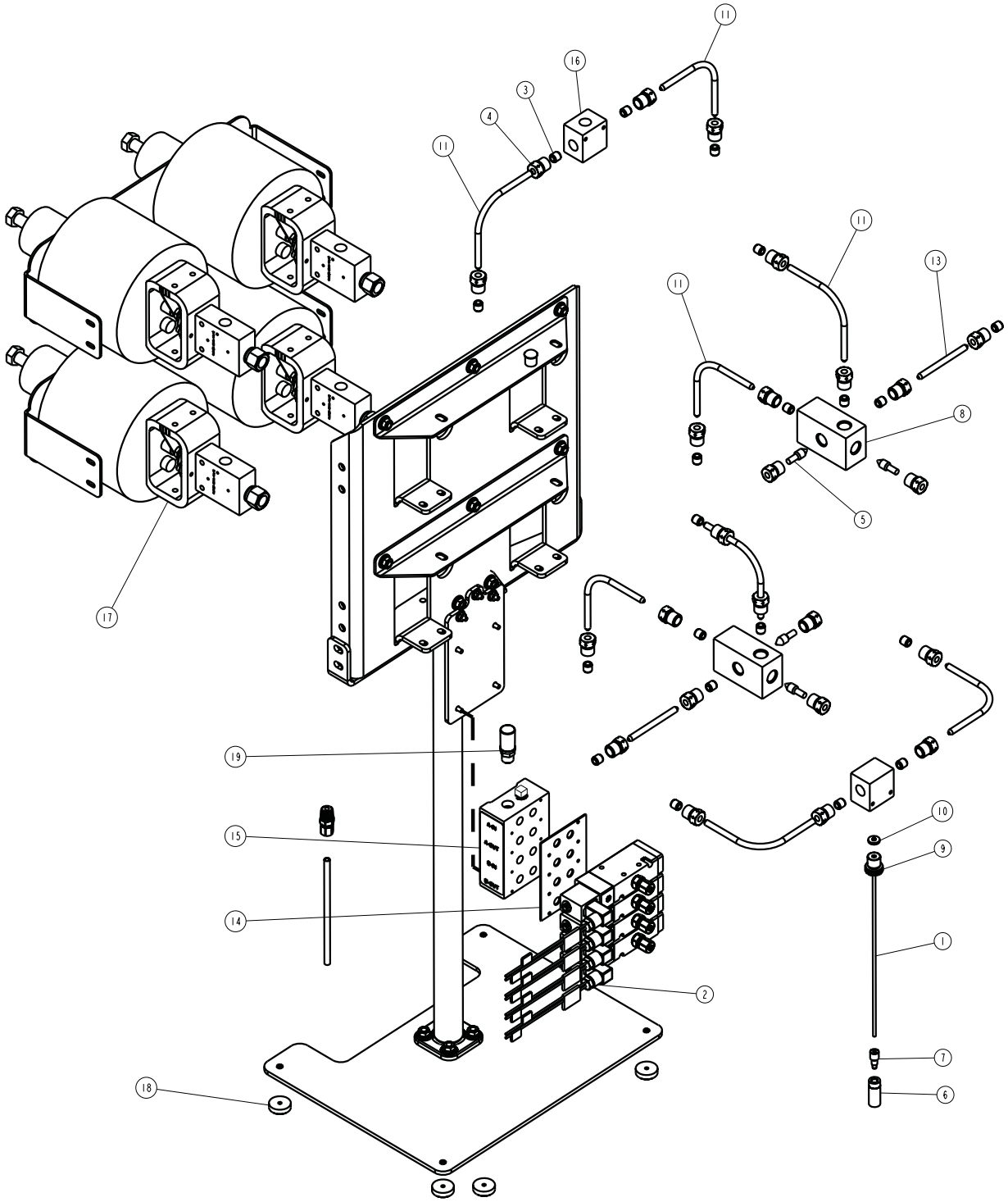
TELEDYNE ISCO

REV: F

ITEM NO.	PART NUMER	DESCRIPTION
35	601263131	SHEAR KEY,30D
36	601264082	ASSY,30D PRESS AMP
37	601267010	COOLING JACKET,ASSY,30D
38	602254132	MOTOR BRUSHES (PKG 2)
39	605363068	DUAL MALE F250C ADPTR KB
40	691243560	SPUR GEAR
41	691243563	EXTENDED WORM GEAR
42	691243800	COMBINATION GEAR
43	691243802	PINION GEAR
44	691264154	REPLACEMENT TERMINAL STRIP ASSY
45	691244413	TRANSDUCER CABLE ASSEMBLY
46	691263096	LABEL,FRNT PNL,30D PMP
47	201629901	BRG NDL 1.3751D 2.0630D
48	201629902	BRG NDL 1.2501D 1.9380D
49	201629951	WSHR BRG NDL 1.3751D 2.0630D
50	201629952	WSHR BRG NDL 1.2501D 1.9380D
51	231200704	SCR SET 1/4-20X1/4
52	232609700	NUT HEX 1/2-20
53	601243201	PAN DRIP
54	601263145	SQUARE AMPLIFIER BOX COVER
55	209016405	PLUG F250C 60K PSI

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

B.6.2 30D Air Valve



601262175

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

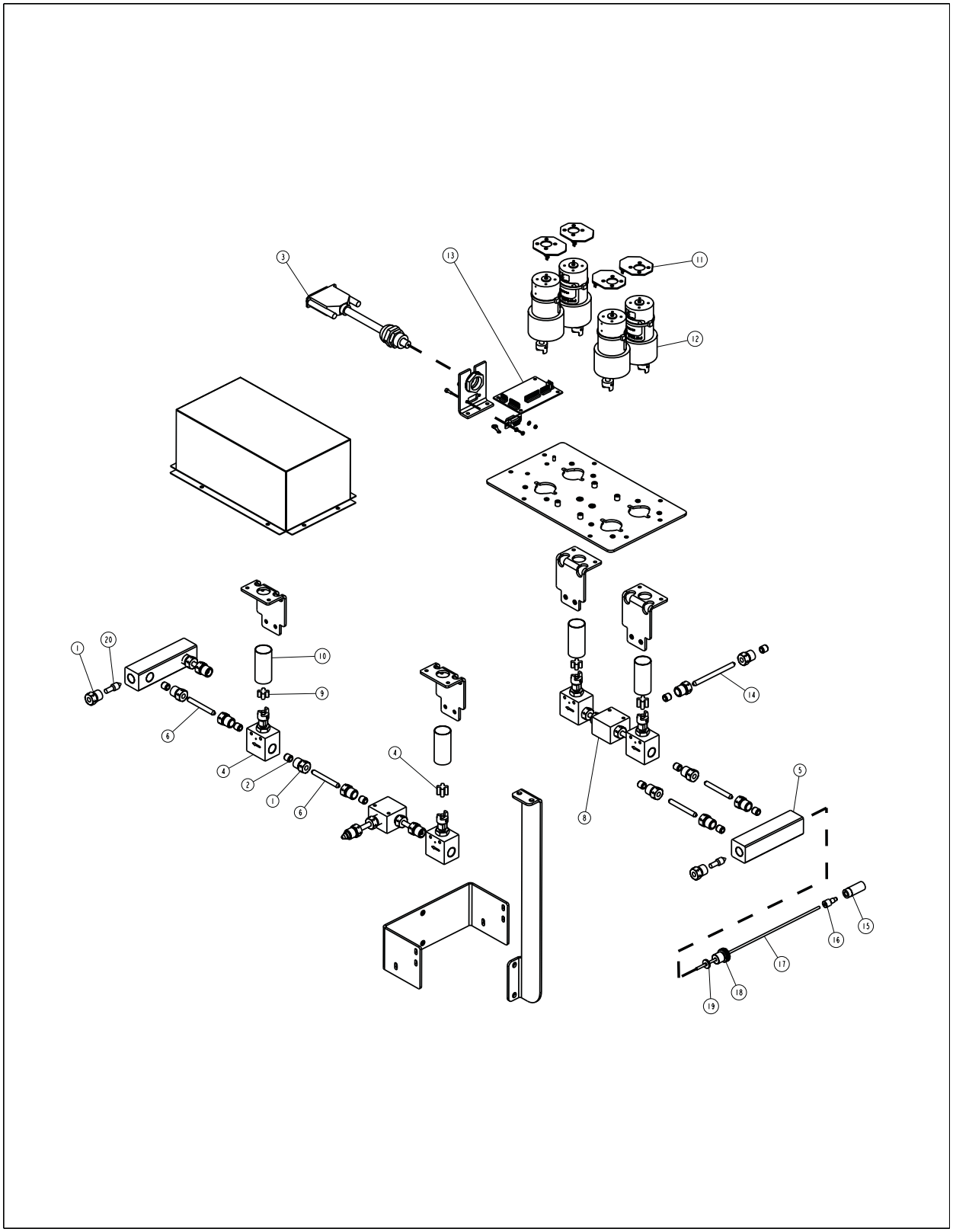
TELEDYNE ISCO

REV: B

ITEM NO.	PART NUMBER	DESCRIPTION
1	023050402	TBG TEF .062 ID
2	209009913	SOLENOID,CNTRL VLV,3-PORT,1/4N
3	209016402	GLAND F250C 30VM
4	209016403	CLR F250C 30VM
5	209016405	P F250C 60K PSI
6	209016980	FLTR REPL 10U
7	209016981	NUT MALE 1/8 TBG
8	601263156	Y-BLOCK,PASSIVATED
9	601263147	INLET NUT
10	601263148	INLET GASKET
11	601263153	TUBE,OUTLET,AIR VLV
12	N/A	N/A
13	601263155	TUBE, 3.1" LNG
14	601263160	MANIFOLD GASKET
15	601263171	AIR SOLENOID MANIFOLD,PAINTED
16	601263173	TEE BODY, PASSIVATED
17	601244496	AIR CYL,MODIFICATION
18	601263167	FOOT,PLASTIC
19	159000002	SILENCER, PLASTIC

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

B.6.3 30D Electric Air Valve



601262176

REPLACEMENT PARTS LIST

SHEET: 2 OF 2

TELEDYNE ISCO

REV:

ITEM NO.	PART NUMBER	DESCRIPTION
1	209016402	GLAND F250C 30VM
2	209016403	CLR F250C 30VM
3	601244312	HARN MN
4	601244494	ELECTRIC VALVE BODY ASSY
5	601263175	E-VLV MANIFOLD, PASSIVATED
6	601263112	1/4"OD X 2.17" TUBE
7	601263141	SPIDER,LONG,E-VLV
8	601263173	TEE BODY, PASSIVATED
9	603933010	SPIDER,SHORT
10	603933061	SHLD CPLG 2.00
11	603934002	CBA MOT KB
12	603934012	MOT ASSY W/CPLR
13	691244348	CBA SENSOR
14	601263142	1/4"OD X 3.18" TUBE
15	209016980	REPLACEMENT FILTER, 10 MICRON
16	209016981	MALE NUT, FOR 1/8" TUBING
17	023050402	TEFLON TUBING, .125 OD X .062 ID
18	601263147	INLET NUT
19	601263148	INLET GASKET
20	209016405	PLUG F250C 60K PSI

NOTE: 1. For current prices and quotations on parts, contact Teledyne Isco Service Department.
2. This list is subject to change without notice.

D Series Syringe Pumps

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NOTICE

Disregard the following “Declaration of Conformity” and Radio Interference Statement” if your instrument does not have a CE label on its rear panel

Radio Interference Statement

FCC

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.

Canada

This ISM apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Ce générateur de fréquence radio ISM respecte toutes les exigences du Règlement sur le materiel brouilleur du Canada.

DECLARATION OF CONFORMITY

ISM1-A

Application of Council Directive:	2004/108/EEC – The EMC Directive 2006/95/EEC – The Low Voltage Directive 2012/19/EU – WEEE Directive
Manufacturer's Name:	Teledyne Isco
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	Series D Series Controller/Pump Controller
Year of Issue:	2014
Standards to which Conformity is Declared:	EN 61326-1:2006 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61010-1: 2010 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2: 2009	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	A A
EN61000-4-3: 2010	Radiated RF Immunity	80 MHz to 2.7GHz 80% AM at 1kHz Level 1 - 10 V/m	A
EN61000-4-4: 2010	Electrical Fast Transient on Mains and I/O	Level 2 - 2kV on AC lines	A
EN61000-4-5: 2005	Surge on AC Lines	2kV common mode, 1KV differential mode	A
EN61000-4-6: 2008	Conducted RF on AC Mains and I/O	150 kHz to 80 MHz, 3V rms, 80% modulated	A
EN61000-4-11: 2004	Voltage Dips/Short Interruptions	0.5 cycle, each polarity 100%	A
EN61000-3-2: 2009,3-3: 2008	AC Harmonic, Flicker		Pass
CISPR11/ EN 55011: 2009	RF Emissions Radiated, below 1 GHz and Conducted, AC Mains	Group 1, Class A Industrial, Scientific, and Medical Equipment	Pass

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of September 09, 2014.

Vikas V. Padhye Ph. D.
Executive Vice President of Sales and Marketing and Product Line General Manager
Teledyne Isco
4700 Superior Street
Lincoln, Nebraska 68504
Phone: (402) 464-0231
Fax: (402) 464-0318

TELEDYNE ISCO
Everywhereyoulook™

60-1262-110
Rev _

DECLARATION OF CONFORMITY

ISM1-A

Application of Council Directive:	2004/108/EEC – The EMC Directive 2006/95/EEC – The Low Voltage Directive 2012/19/EU – WEEE Directive
Manufacturer's Name:	Teledyne Isco
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	Syringe Pumps: 65D, 65DX, 65DM, 65DXX, 65HP, 100DM, 100DX, 100DX2, 100DX4, 260D, 260HP, 260SP, 260DX, 260DXX, 500D, 500DO, 500HV, 500SP, 500DX, 500DXX, 500HP, 500HPX, 1000D, 1000DO, 1000HV, 1000DX 1000DXX
Year of Issue:	2015
Standards to which Conformity is Declared:	EN 61326-1:2006 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61010-1: 2010 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

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EN61000-4-5: 2005	Surge on AC Lines	2kV common mode, 1KV differential mode	A
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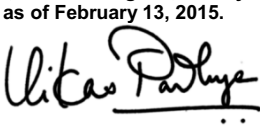
EN61000-3-2: 2009,3-3: 2008	AC Harmonic, Flicker		Pass
CISPR11/ EN 55011: 2009	RF Emissions Radiated, below 1 GHz and Conducted, AC Mains	Group 1, Class A Industrial, Scientific, and Medical Equipment	Pass

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of February 13, 2015.



Vikas V. Padhye Ph. D.
Executive Vice President
Teledyne Isco
4700 Superior Street
Lincoln, Nebraska 68504
Phone: (402) 464-0231
Fax: (402) 464-0318

TELEDYNE ISCO
Everywhereyoulook™

60-1262-111
Rev A

产品中有毒有害物质或元素的名称及含量

Name and amount of Hazardous Substances or Elements in the product

部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
线路板 Circuit Boards	X	O	O	O	O	O
液晶显示 LCD Display	X	O	O	O	O	O
电解电容 Capacitor	O	O	O	O	X	O
接线 Wiring	O	O	O	O	X	O
内部电缆 Internal Cables	O	O	O	O	X	O
外部电缆 External Cables	O	O	O	O	X	O
主电源线 Line Cord	O	O	O	O	X	O
变压器 Transformer	X	O	O	O	X	O
前面板标志 Front Panel Label	O	O	O	O	X	O
小键盘 Keypad	O	O	O	O	X	O
直流电机 DC Motor	X	O	O	O	X	O

产品中有毒有害物质或元素的名称及含量：Name and amount of Hazardous Substances or Elements in the product

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在ST/ 标准规定的限量要求以下。

O: Represent the concentration of the hazardous substance in this component's any homogeneous pieces is lower than the ST/ standard limitation.

X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出ST/ 标准规定的限量要求。

(企业可在此处，根据实际情况对上表中打"X" 的技术原因进行进一步说明。)

X: Represent the concentration of the hazardous substance in this component's at least one homogeneous piece is higher than the ST/ standard limitation.

(Manufacturer may give technical reasons to the "X"marks)

环保使用期由经验确定。

The Environmentally Friendly Use Period (EFUP) was determined through experience.

生产日期被编码在系列号码中。前三位数字为生产年(207 代表2007年) 。随后的一个字母代表月份：A为一月，B为二月，等等。

The date of Manufacture is in code within the serial number. The first three numbers are the year of manufacture (207 is year 2007) followed by a letter for the month. "A" is January, "B" is February and so on.

Teledyne Isco One Year Limited Factory Service Warranty*

This warranty exclusively covers Teledyne Isco instruments, providing a one-year limited warranty covering parts and labor.

Any instrument that fails during the warranty period due to faulty parts or workmanship will be repaired at the factory at no charge to the customer. Teledyne Isco's exclusive liability is limited to repair or replacement of defective instruments. Teledyne Isco is not liable for consequential damages.

Teledyne Isco will pay surface transportation charges both ways within the 48 contiguous United States if the instrument proves to be defective within 30 days of shipment. Throughout the remainder of the warranty period, the customer will pay to return the instrument to Teledyne Isco, and Teledyne Isco will pay surface transportation to return the repaired instrument to the customer. Teledyne Isco will not pay air freight or customer's packing and crating charges. This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

The warranty for any instrument is the one in effect on date of shipment. The warranty period begins on the shipping date, unless Teledyne Isco agrees in writing to a different date.

Excluded from this warranty are normal wear; expendable items such as charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; and damage due to corrosion, misuse, accident, or lack of proper maintenance. This warranty does not cover products not sold under the Teledyne Isco trademark or for which any other warranty is specifically stated.

No item may be returned for warranty service without a return authorization number issued by Teledyne Isco.

This warranty is expressly in lieu of all other warranties and obligations and Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

The warrantor is Teledyne Isco, 4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

Before returning any instrument for repair, please call, fax, or e-mail the Teledyne Isco Service Department for instructions. Many problems can often be diagnosed and corrected over the phone, or by e-mail, without returning the instrument to the factory.

Instruments needing factory repair should be packed carefully, and shipped to the attention of the service department. Small, non-fragile items can be sent by insured parcel post. **PLEASE BE SURE TO ENCLOSE A NOTE EXPLAINING THE PROBLEM.**

Shipping Address: Teledyne Isco - Attention Repair Service
4700 Superior Street
Lincoln, NE 68504 USA

Mailing Address: Teledyne Isco
PO Box 82531
Lincoln, NE 68501 USA

Phone: Repair service: (800) 775-2965 (lab instruments)
(866) 298-6174 (samplers & flow meters)
Sales & General Information: (800) 228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: IscoService@teledyne.com

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